Field Fortification

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Field Fortification

A study of the Western Front in Europe 1914–1916

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PREFACE

This treatise is based on authentic information from the Western front in Europe, but the art and practice of Field Fortification today is like so many other things, in the melting pot, and men who study this work may find, upon their arrival in France that certain methods have been changed; or, what is perhaps more probable, that new methods have been adopted in addition to those set forth.

For example, there is a growing tendency on the part of our enemy to develop centers of resistance rather than continuous lines. In spite of this constant change and development, the general principles, and probably most of the practice here set forth, will be found in application where the forces of the United States are now in training to fight. A manual of this kind is, however, like a technical dictionary. You buy the last one obtainable and should not expect words and descriptions of processes which have come into use after the date of publication; the others still hold good, or most of them still hold good. The editor with the best intentions in the world cannot see just what tomorrow will bring forth.

It is accordingly hoped that this manual will be found useful in the primary military education which the soldiers of the United States are preparing themselves to continue in France and to complete in Germany, the home of technical training.

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CHAPTER I

PART I.

GENERAL PRINCIPLES AND CLASSES OF DEVICES OF FIELD FORTIFICATION.

1. The power of modern armament (rapid fire rifles, automatic rifles, machine guns, field guns, heavy field guns, and trench weapons) requires that troops, both on the offensive and defensive, constantly seek cover in order to avoid heavy losses.

2. A *trench* is a shield that saves losses and increases the immediate defensive and the future offensive power of troops who know how to use it. It permits infantry to halt in safety under fire, in order to continue the advance when a favorable opportunity offers. Under penalty of complete destruction, it is absolutely necessary for attacking troops to shelter themselves when under fire, and to fortify, step by step, the ground won. Troops that cannot reach the enemy by an uninterrupted advance are enabled to stop and prepare for the next advance by means of the fortification of the terrain.

3. Field fortification likewise enables the offensive to engage the enemy, to hold him on one part of the front so as to concentrate forces and reserves, and strike him at another part of the front.

4. The passive defense should be avoided. When troops have once dug themselves in, or organized supporting points, required by the tactical conditions existing, they must profit by their work and carry out the mission assigned them, by coördinating the action of the intrenched units with that of the units intended for the counter attack, which are protected by the natural features of the terrain.

5. This preparation for an attack which may last weeks and months does not bring about immobility, but permits an economy of forces in certain places, and a concentration of strength in others, with a view to sudden and decisive action.

6. The soldier properly instructed, disciplined, led and imbued with the principle that the offensive dominates all the actions of war and that it is the indispensable condition of success, will not hesitate any more to quit the trench than he would to leave a furrow or a road-side ditch in order to advance when ordered by his chief. Napoleon said: "The trench is always useful, never harmful, when it is properly understood. To argue that victory belongs to the one who marches, advances, manœuvres, and that it is unnecessary to work, is to talk lightly and foolishly."

7. The fortification of the battlefield includes the opening of communications, work to facilitate the movements of troops to the front and to improve their fire, demolitions on the front of fortified positions and in the rear of a column in retreat, illumination of the battlefield, obstacles, and finally, the means for protection against these devices.

8. The *principal devices* which permit the development of the maximum power of troops, and are the component elements of all field fortification, are:

First, *cover,* which protects against fire, while permitting a good use of firearms.

Second, *obstacles,* which increase the power of a fortification by holding the enemy under fire of the defenders.

Third, *view,* which permits the defenders to fire and to see what is going on. Artillery fire, especially, needs long and extended views; hence the necessity for having observing stations and for holding securely those points of the terrain which afford positions for them.

Fourth, *communications.* These assure the rapid transmission of orders, rapid and sure movements of troops and material.

PART II.

RÔLE OF FORTIFICATION ON THE WESTERN FRONT IN EUROPE, 1914–16.

9. Before the superiority of numbers of the Germans (22 corps against 17), the position taken by the French on the front Sambre-et-Meuse on August 21, 1914, was broken on the 23d. The Germans had already made use of intrenchments plentifully supplied with machine guns to break the French offensive. The retreat was effected in the center and left wing of the French army, while the right wing, resting on the Vosges and on the Meuse River, held fast and formed a pivot. This right wing employed field fortification, both light and reinforced, to the fullest extent. It immediately abandoned the regulation types for deeper and narrower profiles.

10. On September 5th, the order for the offensive was given. The French armies stood fast and dug in, and the Germans did likewise. But they still used the light form of fortification, utilizing at first rivers, streams, marshes, earth walls, cuts and fills of roads and railroads, reinforcing these natural obstacles by light intrenchments and simple lines of barbed wire stretched through the growing crops.

11. The French offensive succeeded and the Germans retreated. But the exhaustion of the troops' energy and ammunition became evident on both sides, and the slowness of the pursuit permitted the Germans to dig in and form on the right bank of the Aisne a fortified barrier, utilizing natural obstacles of the most diverse kinds to shelter and strengthen firing lines, to hide and protect batteries of all calibers, to shelter reserves, and headquarters, and to reorganize supply in food and ammunition. This barrier forms an extended front, an uninterrupted succession of supporting points, of centers of resistance, natural and artificial, mutually supporting each other, yet so disposed that the fall of one does not bring about the fall of others, the whole presenting a close analogy with the defensive organization of a modern fortified place, with its advanced positions, its principal line of defense, its supporting positions and its central nucleus.

PART III.

USE OF FIELD FORTIFICATION ON THE OFFENSIVE AND ON THE DEFENSIVE.

Use on the Offensive.

12. In the *preliminary operations,* the Advance Guard has as its mission:

To clear away obstacles.

To attack the enemy so as to oblige him to show his force.

To occupy the supporting points necessary for the deployment of the main body, and if necessary to capture them.

To organize supporting points.

13. *During the approach,* it is still the mission of the Advance Guard:
To destroy obstacles.
To open communications to the front.
To improvise means of crossing obstacles.

14. *During the forward movement after deployment,* it is necessary:
To destroy or open passages through obstacles.
To improvise means of crossing obstacles.
To improve the cover against view and against fire.
To construct obstacles.

15. *During the combat* it is necessary, rush by rush, and step by step:
To utilize the cover afforded by the ground.
To improve this cover.
To construct cover, where natural cover is lacking.

In general the principle is that when the skirmish line can no longer advance, it must dig in; one man out of two digs, while the other fires.

16. *During the assault,* the assaulting troops:
Will utilize the defiladed or covered lines of approach.
Will clear the routes to be followed.
Will open passages through obstacles.
Will improvise means of crossing obstacles.

17. *During the pursuit.*—Troops following the assaulting line will thoroughly organize the ground won.

18. *In case of breaking off the fight.*—The retirement will be effected under the protection of a position organized in rear by fresh troops utilizing the cover previously occupied and held.

Use on the Defensive.

19. The defensive organization of a natural supporting point and of a center of resistance are to be treated in later chapters, so that only the steps to be taken in case of emergency will be mentioned here.

20. *Improving the field of fire:*
Works permitting front and flank fire.
Clearing the field of fire.
Obtaining the ranges of various points in the field of fire.

21. *Construction of cover against sight and fire.*

22. *Establishment of communications:*
Forward to advanced positions for observation.
Laterally, to connect the parts of the firing line.
To the rear, to permit the reinforcement of the firing line.

23. *Accessory defenses:*
Obstacles in front of the firing line.
Measures to protect points of passage.
Strengthening of intrenchments, building of shelters, commanders' stations, etc.

PART IV.

THICKNESS FOR DEFENSIVE AGAINST FIRE OF INFANTRY, ARTILLERY AND TRENCH WEAPONS.

24. The object of an intrenchment is to protect the defender, whether at rest or in the firing line, from hostile projectiles. Its profile therefore depends upon the armament in use, and it is necessary to study the effect of projectiles.

Infantry Fire.

25. The rifle, the machine gun and the automatic rifle, adopted by the different powers, throw a cylindro-ogival bullet, which has at the short and mid-ranges a considerable remaining velocity. Its penetration varies according to the ballistic force of the arm, the substance traversed, and the form of the bullet.

26. *Bullet D (French) and Bullet S (German).*—Bullet D is entirely of brass, of bi-ogival form, and 1.53 inches long, figure 1. Bullet S is formed by a core of lead, "a," figure 2, surrounded by a jacket of steel, "b," and plated with German silver. Its front part is cylindro-ogival; its rear part, cylindrical. It is 1.1 inches long. Bullet D weighs 197.5 grains and has an initial velocity of 2360 feet. Bullet S weighs 154 grains and has an initial velocity of 2820 feet. From 0 to 900 yards the trajectory of the bullet S is flatter than that of D; beyond 900 yards, the reverse is true. The accuracy of the bullet D becomes clearly superior to that of S, but the curved trajectory of the bullet S permits it to search depressions and to reach the reserves in rear.

27. *Thickness for protection against the German Bullet S* (at all distances).

Nature of material	Thickness
Earth (necessary thickness for all cases)	3 ft. 4 in.
Sand	2 ft. 6 in.
Manure	9 ft. 10 in.
Saplings and soft wood	2 ft.
Oak and hard wood	1 ft. 4 in.
Hay rick	19 ft. 8 in.

Sand-bags.—Beyond 400 yards, one length of bag; from 400 to 100 yards, 1½ length; from 100 to 50 yards, 2 lengths; at less than 50 yards, 4 lengths.

Steel Shields.

Sheet-steel.—2 sheets of steel of .16 in., one behind the other at 1.2 in., practically stop the bullet, as a third sheet is only dented.

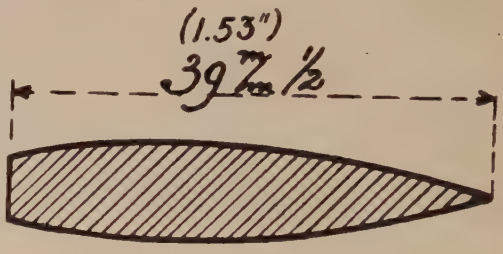


Fig. 1. —

Artillery shields of .2 in. are only perforated at distances less than 350 yards. Shields for attack, and Parapet

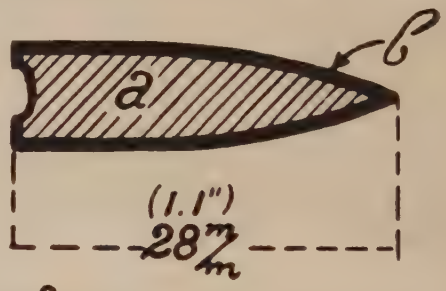


Fig. 2. —

shields of special steel are not perforated by the bullet S at distances greater than 150 yards. Two shields placed at a few inches from each other stop the bullet at 25 yards. Shields are now being manufactured which stop the bullet at 50 yards.

Nature of material	Thickness
Walls of rammed earth	2 ft.
Walls of brick	1 ft. 8 in.
Walls of rubble	1 ft. 4 in.
Loose snow	9 ft. 10 in.
Packed snow	3 ft. 4 in.
Frozen snow	3 ft. 4 in.

Sheet-steel and Sand.—2 sheets of .12 in. separated by 1.6 in. of sand stop the bullet at 10 yards.

Wood and Sand.—The same result is obtained with a cover of 1.8 in. of oak and 2.4 in. of pine.

28. *Armor piercing bullets.* — The Germans have employed a special armor-piercing bullet called SMK, of steel with a brass jacket and slightly truncated. This bullet perforates the special steel sheet of less than .47 in. at all distances, and of .55 in. at 50 yards. The resistance of the plate increases rapidly with the angle of incidence of the bullet.

The bullet S turned end for end in the shell has a great penetrative power at short range, but it then acts like a dum-dum bullet.

By truncating the bullet D so that it presents a cross section at .1 in. from the point, a great penetrative power against shields is given for short ranges (Fig. 3). A steel bullet has recently been put into the French service.

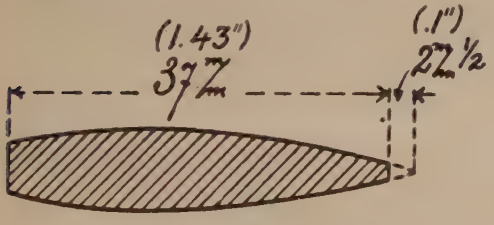


Fig. 3.—

Artillery Fire.

29.—*Employment.*—In field warfare the French Artillery uses projectiles with wide range of action; it employs, for this purpose, high explosive shell and shrapnel. The high explosive shell of the 75 (2.9 in.) fired with sufficient density, due to its rapidity of fire, has a terrible effect on dense formations. Most of the guns used have a flat trajectory.

The German Artillery, on the contrary, has preferred heavy projectiles, fired with large angles of fall, with violent but very local action; so, in spite of a prodigious expenditure of these projectiles, the results have been small.

In position warfare, the 75 (2.95 in.) gun has always played a preponderant rôle, while the German 77 (3.03 in.) has not been nearly so effective. Moreover, if the heavy artillery is compared, the long French projectiles are superior to the German of the same calibre by reason of the greater weight of explosive that they carry.

30. *Action of the projectiles.*—Shells bursting at a certain distance above the ground, either before reaching it (fuse) or after ricochet, produce two kinds of sheafs, viz., narrow and open. Shells bursting upon impact or after slight penetration (delayed action) are used either against personnel or for the destruction of obstacles. In general, the same projectile can be used for either purpose.

31. *Shell used against personnel.*—For this purpose there are used shrapnel of 77 mms. (3.03 in.), 90 mms. (3.5 in.), 10 cms. (3.93 in.), 13 cms. (5.12 in.), 15 cms. (5.9 in.), and 21 cms. (8.27 in.) which contains 170 lead balls of 26 grammes and 135 steel balls of 150 grammes. These balls are more than 1.2 in. in diameter and can act efficiently against shields.

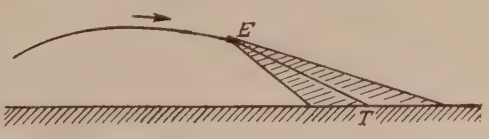


Fig. 4.—

The combination shell 105 (4.13 in. light howitzer) is also used for this purpose. It is fired like shrapnel, time or percussion.

32. *Shell with closed sheaf.*—In the shell bursting at E (Fig. 4), the balls

which it contains are thrown into the interior of a cone having for an axis the tangent ET to the trajectory.

The trace on the ground is oval in form, the part with most hits (effective zone) being situated nearest the bursting point (Fig. 5).

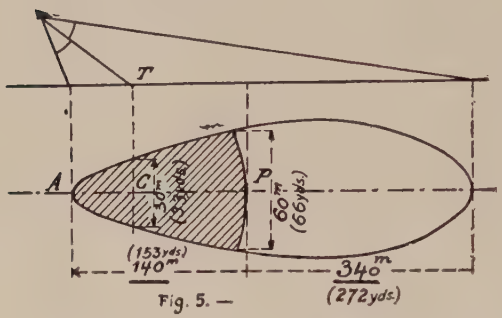


Fig. 5. —

For a given ball, the danger zone then comprises all the distance AC on the ground on which a man standing will be hit (Fig. 6). The flatter the trajectory the longer will be AC.

Fig. 6. —

If the personnel is sheltered behind a parapet, the flatter the trajectory and the narrower the sheaf the more the personnel will be sheltered. The more

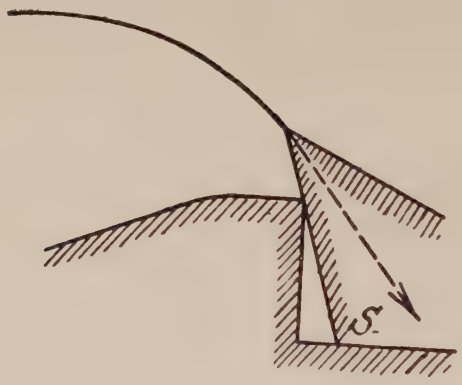


Fig. 7.

curved the trajectory and the more open the sheaf the more the personnel will be exposed (Fig. 7).

If the personnel is protected by a roof covered with 4 in. of earth, the balls will be stopped.

When the shells are percusson fired for a small angle of fall (15°, Fig. 8),

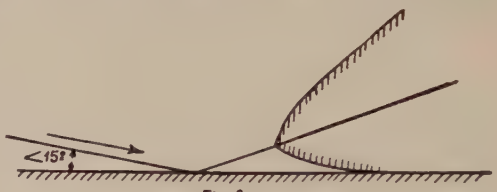


Fig. 8. —

they burst after the ricochet; the sheaf obtained sweeps the ground well as long as the angle of rise remains small; this angle increases with the angle of fall; a time may come when all the sheaf will pass over the target.

23. *Shell with open sheaf.*—The necessity for reaching the personnel behind a parapet or behind vertical shields has led to the invention of projectiles giving a sheaf of balls or fragments spreading in a direction approaching the normal to the trajectory. To this type belong the French " unit " shell, and the German high explosive shell of the 77 gun and 105 howitzer. The German 77 high explosive shell bursting with time fuse, gives a hollow sheaf of 114° (Fig. 9). This sheaf is composed of fairly

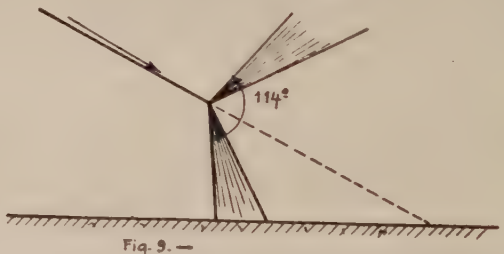


Fig. 9. —

large fragments, few in number, and of low initial velocity. Certain fragments are still effective at 15 yards, as a maximum to right and left. The action is very local, and none at all if the fire is not well regulated, on account of the narrowness of the sheaf.

The German shell of the light howitzer has very thick walls, and small explosive chamber. The sheaf is hollow, more open than the preceding one (200°, Fig. 10). The radius of action

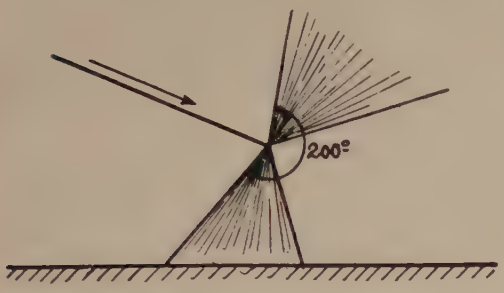


Fig. 10. —

is 25 yards. There is the same difficulty of regulating fire as for the preceding type.

34. *Shells used against materiel:*

Shrapnel, old type and modern.— These projectiles have sufficient power to be employed with percussion fuses against the matériel of artillery, walls, houses, etc.

High explosive shell.—As the use of the delayed action fuse may impair the action of the high explosive shell in certain cases, instantaneous detonating fuses are used. Shells provided with these burst immediately upon impact. They are used advantageously against walls, matériel, parapets, barbed wire entanglements, abatis, etc. Fired into the earth, these projectiles produce craters. They can therefore destroy heavy parapets. Against masonry covered with earth, delayed action fuses are used.

The German 90 mm. shell (3.54 in. with .36 lbs. of explosive) and that of the 77 mm. (3.03 in. with the same explosive charge) give results very inferior to those of the French 75 mm.

The German 105 mm. shell (4.13 in. with 2.2 lbs of explosive) is more effective than thatof the 77 mm.

The German shell of the heavy howitzer, 15 cms. (5.9 in. with 10.36 lbs. of explosive) is intended to act by its fragments. These can penetrate artillery shields at 40 yards to the right and left, 5 yards forward and 25 yards to the rear.

The German 10 cm. shell (3.93 in. with 4.4 lbs. of explosive), that of 13 cm. (5.12 in. with 8.8 lbs.) and that of the 15 cm. (5.9 in.) gun give results similar to those of the heavy howitzer.

The German 21 cm. shell (8.27 in. with 33 lbs. of explosive) is intended to be used against steel plates and concrete; it is often used against buildings. Its effect is very destructive but local.

The German 28 cm. shell (11.02 in. with 22 lbs. of explosive), armor piercing, or semi-piercing, with very strong ogive, is intended for concrete and masonry. It gives craters of small dimensions.

The German 305 mm. shell (12 in. with 44 lbs. of explosive) or Skoda mortar, armor-piercing projectile, is intended to attack concrete forts.

The German 42 cm. shell (16.5 in. with 88 lbs. of explosive) is employed for a similar purpose. In a mass of concrete it produces a wide but shallow crater, and can produce serious trouble in the delicate machinery of forts, such as turrets, etc.

Fire of Trench Weapons.

35. To the fire of Infantry and Artillery is now added that of *Trench Weapons.* These weapons, such as bombs, grenades and torpedoes, can be compared, so far as their effect is concerned, to the artillery projectiles. In France, bombs and grenades, thrown by hand or by machines of low power

(cross-bows, slings, howitzers, mortars) give, on bursting, fragments which are similar to those of the 75 mm. shell.

Their force ceases to be deadly beyond 25 yards. Bombs and torpedoes thrown from 500 to 1800 yards by apparatus of high power (guns of 58,240 and 340 mm. (2.28, 9.48 and 13.38 in.) and howitzers of 75 mm.) and containing from 35 to 220 lbs. of explosive, produce craters as deep as those caused by projectiles of the heaviest calibres. They cause the destruction of shelters, protected by armor and concrete, as well as the cave shelters more than 26 feet underground.

36. The Germans employ bombs, grenades and torpedoes similar to the French. Their bombs and torpedoes are thrown by Minenwerfer of different models. The principal ones are:

Of small calibre, 7.5 cm. (2.95 in.) weighing 108 lbs., range 1150 yards, projectile weighs 10.1 lbs. and contains 2.2 lbs. of explosive. It is called a light mine.

Of medium calibre, 17 cm. (6.7 in.), range 850 yds., projectile contains 15.4 lbs. of explosive; called a medium mine.

Of heavy calibre, 24.5 cm. (9.64 in.) weighing 1322 lbs., range from 450 to 900 yds., projectile weighs 220 lbs. and contains 110 lbs. of explosive; called a heavy mine.

37. *Thickness for protection against light artillery and trench weapons of low power:*

38. *Thickness for protection against heavy artillery and trench weapons of high power:*

150 mm. (9.5 in.) howitzer: 2 layers of saplings of 6 in. and 2 layers of earth of 1 ft. alternated.

210 mm. (8.26 in.) howitzer: 3 layers of saplings of 6 in. and 3 layers of earth of 1 ft. alternated and reinforced by flagstones, sacks of cement, rubble, or railroad rails.

280 mm. (11.02 in.) howitzer and calibres above: 17 to 33 feet of undisturbed earth (cave shelter).

39. *Blast.*—Besides the metal fragments, there is the blast against which protection must be provided. This blast is caused by the explosion of the projectile, and is strong enough to overturn walls, break in doors and knock furniture and men about. The commotion produced results in nervous effects often mortal. Moreover, the action of the gas produced is very dangerous and causes long and serious illness. Their effects are not usually noticed for some days after the explosion, and they produce loss of hearing, sense of smell, of taste, of sight, as well as paralysis, and prolonged fainting spells. The cure is very slow.

Protection against this double effect of blast is obtained by:

1st. Making the trenches as narrow as possible.

2d. Dividing up the works into small

Fuse	Nature of material	Direct hit	Oblique hit
Time	Low earth	16 in.	4 in.
	Hard wood	6 in.	3 in.
	Soft wood	10 in.	6 in.
	Brick	2½ in.	
	Steel sheet	.1 in.	
Percussion	Projectiles of the 77 mm. gun	3 ft. 4 in. of earth.	
	Projectiles of the 105 mm. howitzer	7 to 10 ft. of earth.	

sections by increasing the number of traverses.

PART V.

INTRENCHING TOOLS FOR INFANTRY, CAVALRY AND ENGINEERS.

40. Two things are needed for field works: men and tools. The men are supposed to be engineer soldiers; as a matter of fact, they are almost always infantry men.

Troops of all arms have a supply of tools which comprises:

Tools for earth work—shovels, picks and pick mattocks.

Tools for demolition — hand-axes, bolos, wire cutters, axes, crowbars, and saws.

Tools are classed as portable tools, carried on the person of the soldier; and park tools, carried on wagons or pack mules.

41. *Tools for Infantry:*

Portable tools for each company:

34 pick mattocks, with carriers.
17 wire cutters, with carriers.
8 hand-axes, with carriers.
9 bolos, with scabbards.
68 shovels, with carriers.

Park tools for each regiment:

26 axes.
7 crowbars.
150 pick mattocks.
450 sand bags.
13 saws, hand.
13 saws, two-man.
300 shovels.

42. *Tools for Cavalry:*

Portable tools for each troop:

8 hatchets with covers.
24 picks, with covers.
72 shovels.
105 wire cutters.
1 sledge hammer.

Park tools for each regiment:

26 axes.
7 crowbars.
150 pick mattocks.
13 saws, hand.
13 saws, two-man.
300 shovels.
450 sand bags.

In addition each squadron has a demolition outfit carried on a pack mule.

43. *Tools for Engineers:*

Each company carries in 2 tool wagons:

4 adzes.
26 axes.
2 pinch bars.
4 sledge hammers.
6 hatchets.
18 gabion knives.
36 machetes.
4 mauls.
4 peevies.
6 picks, railroad.
36 pick mattocks.
18 pliers.
2 posthole diggers.
2 saws, 1-man.
4 saws, 2-man.
72 shovels.
Miscellaneous tools and supplies, including demolition and carpenter tools.

In addition 8 pack mules carry miscellaneous tools and supplies for intrenching, pioneer and demolition work.

Each battalion headquarters carries in a wagon a complete blacksmith's equipment.

For complete lists of above equipments see Unit Accountability Manual issued by A. G. O.

44. The duties of the Engineer troops in connection with field fortification pertain both to the attack and the defense and include the selection of defensive positions when out of the presence of the enemy; rectification of and assistance in the selection of such positions in the presence of the enemy; the

location, design, and construction of the more important field works; assistance in and supervision of the construction of the hasty defenses wherever possible; the supply of tools and materials, and the reconnaissance, demolitions, water supply and communications incident thereto.

CONCLUSION.

45. Such is the matter preliminary to a study of field fortification. This subject must be thoroughly studied for proper preparation for modern warfare. The time has passed for "ramparts of human breasts," and the warlike ardor which will break up all assaults." We must know how to dig and how to make war with pick and shovel as much as with weapons. Experience has shown us that courage must be sheltered until it can be usefully employed in the open.

It is the daily work, faithfully done in all weathers and under all circumstances, that gives glorious results. There is no undignified element in warfare. The men who dig and work at transport of supplies and ammunition are as meritorious as those who fire and charge. They all work to a common end—for the common defense.

CHAPTER II

UTILIZING NATURAL COVER, PROFILES AND EXECUTION OF LIGHT FIELD FORTIFICATIONS

PART I

INFANTRY.

1. Its mobility:

The infantryman marches slowly but is capable of prolonging his advance either by day or night, in hot or cold weather, on all terrain, far or near the enemy and in spite of the latter's fire. This characteristic enables infantry to approach an enemy, attack him with the bayonet, and drive him from the positions he occupies.

2. Ability to utilize natural cover:

Infantry, more than any other arm, is capable of utilizing the shelter and cover of the terrain. The terrain is its natural ally. This ability to utilize the terrain enables it to economize strength and reduce losses.

To enable him to advance under fire the infantryman has been supplied with *fire arms*. To increase his ability to utilize the terrain, he has been supplied with tools which enable him to make temporary shelters and to organize strongly the positions won.

The infantryman thus acquires, by a combination of arms and tools, the ability to take and hold the terrain he has won from the army. As the Russian Captain Soloview remarks:

The infantryman should regard his spade as the faithful friend of his rifle and not consider it a useless load.

PART II

CONCEALMENT AND PROTECTION.

3. *A screen or mask* consists of hedges, crops, underbrush, etc. which hide the rifleman without, however, protecting him from fire.

4. *Cover or shelter* consists of walls, earthworks, etc. which protect the rifleman from fire.

5. On the battlefield, natural features that screen and shelter should be utilized as much as possible, as they possess the following advantages over artificial works:

(*a*) Their organization demands less work.

(*b*) Concealment is easier.

(*c*) From their nature, it is difficult for the enemy to estimate, for a given length, the number of men sheltered.

6. They possess, however, certain disadvantages:

(*a*) The protection is sometimes so excellent that, morally as well as materially, it becomes difficult to leave the shelter.

Example: quarries with obstructed exits. Therefore, good judgment must be exercised in the selection.

(*b*) Some of them are too visible. Example: large hedges. In this case their range can be easily found.

As a general rule, do not occupy them uniformly and do not change the appearance of the organized parts.

7. Organization of the cover:

To organize the cover which protects troops from fire, construct suitable positions for firing and resting. To utilize the screens which merely hide the troops without protecting them from fire, dig trenches behind these screens in the following manner:

(*a*) Choose the points which give the best field of fire.

(*b*) Construct cover for firing.

(*c*) Construct a shelter.

The constructions are usually "individual" in the first period of work; afterwards, they are organized "collectively." The covers are: (1) for riflemen lying down, (2) for riflemen sitting down, and (3) for riflemen standing up.

INDIVIDUAL ORGANIZATION OF NATURAL COVER

8. Examples of hasty individual cover behind trees, bushes, or branches:

(*a*) Fallen tree (logs or branches), the height of which is at a maximum of 1 foot above the ground:

FIG. 1.—Use of the cover without improvement.

FIG. 2.—First Period

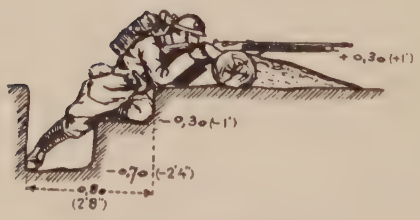


FIG. 3.—Second Period.
Progressive improvement of the cover.

(*b*) Fallen tree, the top of which is more than 1 foot above the ground.

FIG. 4.—First Period.

FIG. 5.—Second Period.

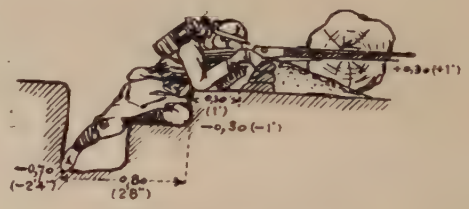


FIG. 6.—Third Period.

Wood which does not afford sufficient protection against bullets must be reinforced by earth at the right and against the cover 1 foot behind. The three figures above show the progressive improvement of the cover.

FIG. 7.—Sharp ridges, furrows, or top of a crest at the end of a gentle slope.

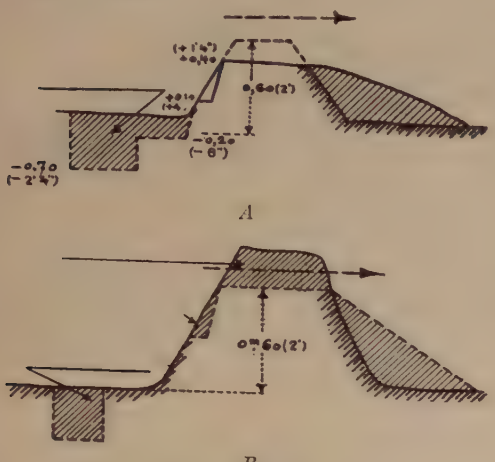
9. Examples of hasty individual covers behind a furrow, a crest, a heap of sand or earth:

Dig the ground as near as possible to crest A of the furrow in the manner indicated for the cover installed behind a fallen tree more than 1 foot high.

FIG. 8.—Narrow furrows.

Use the earth excavated between furrows A and B to build up the earth be-

tween furrows B and C and fill up furrow C; continue afterwards as for the sharp ridge.



A

B

FIG. 9.—Low wall of earth, or earth and sand heaps, more than 2 feet high (two methods, *A* or *B*).

(A) Lower the height about 8 inches; throw the earth forward. Dig a trench as indicated in the figure.

(B) Make a loophole in the pile of earth, showing oneself as little as possible. Improve the firing position by making a place for the right leg and an elbow rest.

10. Examples of hasty shelters (individual) arranged behind a large stone or heap of stones:

A heap of stones, the top of which is 1 foot at a maximum above the ground:

FIG. 10.—First Period.

FIG. 11.—Second Period.

GENERAL ORGANIZATION OF NATURAL COVER

11. This consists in connecting up and co-ordinating the individual work under the direction of the squad commander. The work should be carried out on the lines adopted for the individual work; and the rules prescribed for the construction of artificial cover (profiles, depths, various shelters) should be followed as far as possible. In arranging the cover, the squads should utilize the natural features of the terrain.

FIG. 12.—Arrangement for a mound of earth.

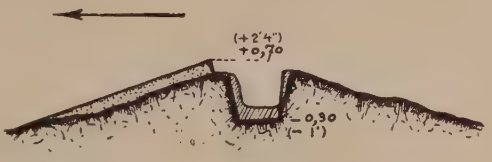


FIG. 13.—Arrangement for a dry ditch.

FIG. 14.—Arrangement for a sunken road defended on the side towards the enemy.

FIG. 15.—Arrangement for a sunken road defended from the rear.

12. Ditches full of water, drains, streams:

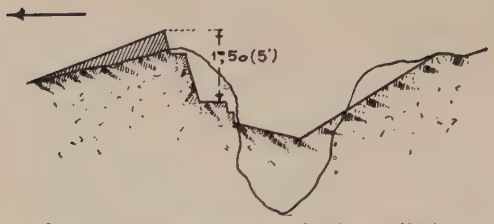


FIG. 16.—Arrangement of a large ditch.

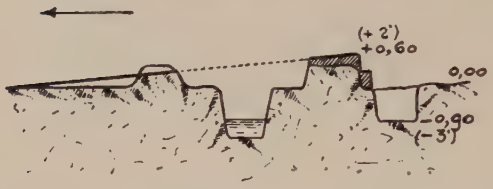


FIG. 17.—Arrangement of a ditch full of water.

13. Ordinary roads, road and railroad embankments, and sunken roads:

FIG. 18.—Arrangement of an ordinary road defended on the side toward the enemy.

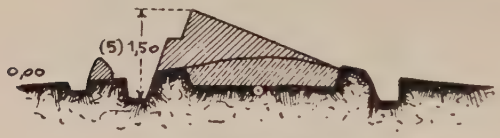


FIG. 19.—Same defended from the rear.

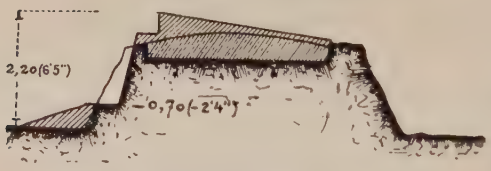


FIG. 20.—Road embankment, defended from the rear.

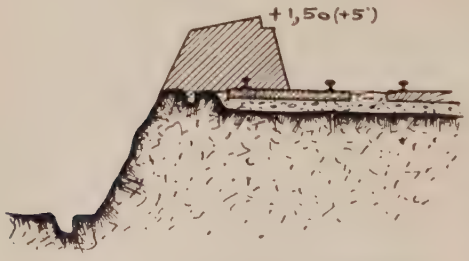


FIG. 21.—Arrangement of a railroad embankment.

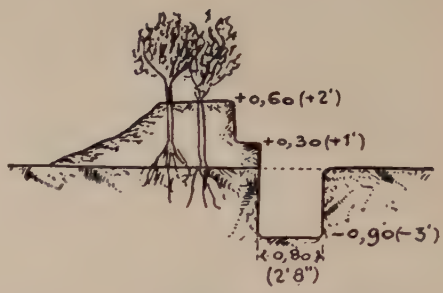


FIG. 22.—Arrangement of a sunken road.

14. Hedges and woods:

Dig a trench behind the hedge and throw the earth against it; make openings in the hedge to facilitate view and fire (Fig. 23). If the hedge is low deepen the trench, but make the parapet lower than the hedge which masks it.

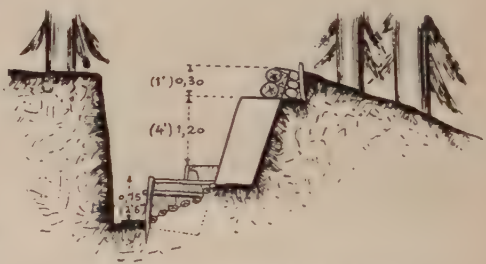


FIG. 23.—Arrangement of a hedge.

FIG. 24.—Arrangement of the edge of a wood.

Avoid destroying the natural appearance of the wood; do not cut the trees and brush on a certain depth, but cut off branches where necessary to obtain a field of fire. Behind this strip cut the brush and small trees so as to make a path 3 to 4 yards wide. Construct a trench behind the mask of trees. The

parapet can be raised up to 2 or even 3 feet. Construct abatis on the parts of the border of the wood, where it will not interfere with the fire.

15. Walls:

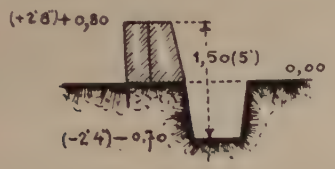


FIG. 25.—Arrangement of a wall, 2 feet 8 inches high.

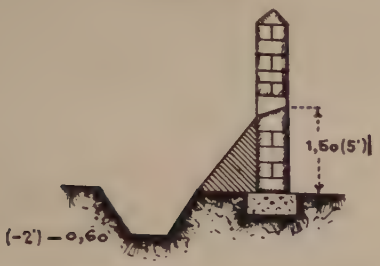


FIG. 26.—Arrangement of a wall 8 feet high.

FIG. 27.—Arrangement of a wall more than 8 feet high without making loopholes.

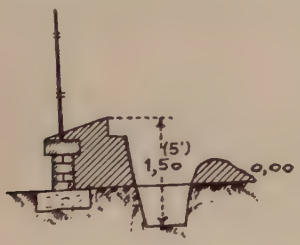


FIG. 28.—Arrangement of an iron fence built on a low wall.

PART III

ORGANIZATION OF ARTIFICIAL INTRENCHMENTS. TYPES OF LIGHT FIELD FORTIFICATIONS.

16. An *intrenchment* is a "cover" arranged so as to permit firing. It is *natural* if it is arranged by using any existing cover, such as: walls, ditches, earth heaps, etc. It is *artificial* if it is entirely constructed. In any case it must provide:

A *cover* against hostile fire.

An *obstacle* to the movements of the enemy.

View to enable the occupant to fire and obtain information of the enemy.

Communications for the rapid transmission of orders and supplies.

17. Conditions which a field fortification should fulfil:

(*a*) A clear field of fire: This is the primary condition to which all others must be sacrificed. This condition requires considerable height for the parapet. But in order to avoid visibility and to interfere with the hostile artillery range-finding, a low parapet is advantageous. Considerable height can be used, but only when the skirmish line is burrowing into the ground and the tactical necessities prevent the careful siting of the work. In this case it may be indispensable to raise the parapet to a height which will establish the work entirely above the level of the ground.

2. Protection from fire:

In the old intrenchments, protection was obtained by the thickness of the parapet. Protection is now obtained in the intrenchment with a low parapet, by entirely concealing the riflemen in a narrow and deep trench. Protection from oblique and enfilade fire and blast is obtained by the use of traverses.

Protection against grenades is obtained by proper slopes of the parapet and parados; and by an arrangement of wire netting which stop these projectiles and throw them back.

To complete the protective arrangements, shelters can be constructed of earth and timber, which will give pro-

tection from the 105 mm. (4.1 in.) and 150 mm. (5.9 in.) shells.

3. Positions suitable for firing and resting:

Proper and suitable positions are indispensable. Troops suffer from cramp by a prolonged stay in trenches too narrow and unsuitable, and they cannot advance or retreat. The best arrangement is to provide a bench about 5 feet below the interior crest on half of the trench; it affords a step from which to fire standing, and a seat. In order to fire accurately, the rifleman must have an elbow rest; in order to be steady when firing, he must have a loophole; to fire at night with the maximum of accuracy, it is necessary to establish fixed firing points. Finally, the dimensions must correspond to the average height of a man.

18. Types and profiles of regulation trenches for light field fortification:

A profile is a section of any cover made by a vertical plane perpendicular to its axis, or practically parallel to the direction of fire against and over it.

Although officers are authorized to modify the regulation types, the infantryman should be taught to execute automatically a single type. Experience has shown, moreover, that it is necessary to establish fundamental dimensions which are the best; they must be thoroughly known, and carried out on the ground to within 2 inches by the N. C. O.'s who should be supplied with measuring rods.

19. Execution of the skirmisher's trench by a skirmish line:

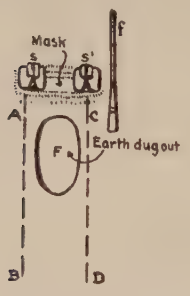


FIG. 29.—First Period. The soldier *AB* digs in *F* and makes a cover between the 2 sacks, *S* and *S'*.

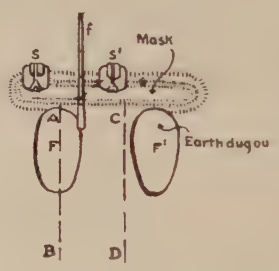


FIG. 30.—Second Period. The soldier *AB* is ready to fire in *F;* the soldier *CD* digs in *F'* and makes a cover to the right of his pack to prolong the preceding cover.

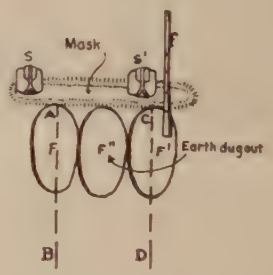


FIG. 31.—Third Period. The soldier *AB* starts working again, between *F* and *F'*, and thickens the cover; the soldier *CD* is ready to fire in *F'*; he draws his pack over to his side.

4. A profile that is progressive and rapidly executed; affording cover and permitting firing while it is being constructed:

From the skirmisher's trench to the complete trench, with a rest bench and even revetment, the profiles of the trenches must be obtained successively, rapidly and without any change in the work already accomplished.

FIG. 32.—Section through *F* (Second Period). Fourth Period and the Following: The two soldiers, *AB* and *CD*, work and fire alternately; they straighten up as they dig down. The packs are taken down as soon as possible, as they are very conspicuous.

20. Sitting trench:

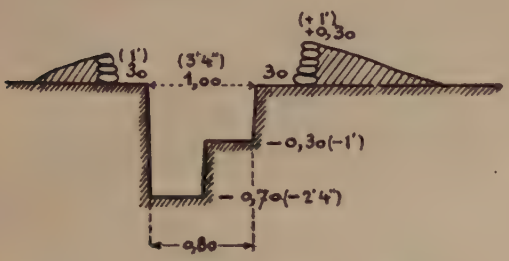


FIG. 33.—Sitting Trench. This is the first result of the work executed methodically and by a group. It is the profile which the firing line under the necessity of stopping and taking cover should endeavor to accomplish. The relief of the parapet above the firing banquette is 2 feet; above the bottom of the trench, 3 feet 4 inches. Time for construction: 30 minutes to one hour.

21. Kneeling trench:

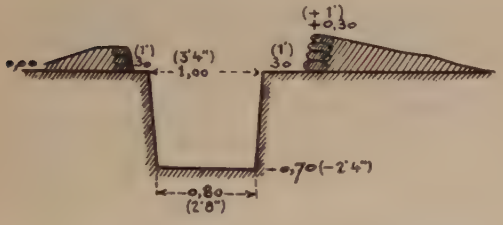


FIG. 34.—Kneeling Trench. This profile is obtained by excavating the banquette. Protection is greater (Fig. 24). Relief: 3 feet 4 inches. Time for construction: 10 to 30 minutes from the sitting profile; or 30 minutes to 1½ hours from breaking ground.

22. Standing trench:

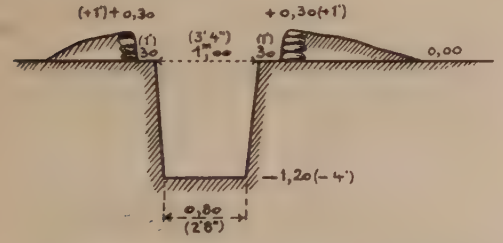


FIG. 35.—Standing Trench. This is used when it is necessary to be firmly intrenched or when a halt is made of sufficient duration to permit its construction. To execute it, the kneeling trench is increased 1 foot 8 inches in depth. Thus a depth of 4 feet is obtained, which affords a better shelter than the trench 3 feet 8 inches in depth; and it is easier to raise the banquette than to repair the damage resulting from its being lowered.

23. Complete trench:

This profile fulfils all the conditions for a field trench (shelter, convenience, rest).

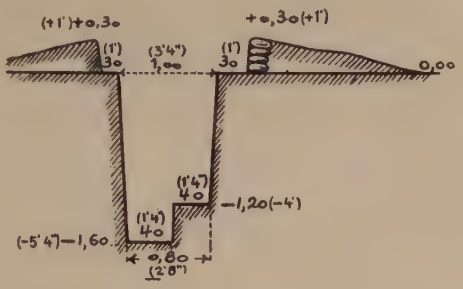


FIG. 36.—Complete Trench. When the trench is finished, it will have a width of 3 feet 4 inches at the top, and 2 feet 8 inches at the bottom. A parados should be provided as a protection from shell splinters. The base of the parados should be one foot from the edge of the trench. Relief: 5 feet above the firing banquette; 6 feet 4 inches above the bottom of the trench. Time for construction: 45 minutes to 2 hours from the standing trench; or 1¼ to 2½ hours from breaking ground. It varies largely, depending upon how tired the men are, material and tactical circumstances under which they operate and on the tools at their disposal.

24. Profiles on difficult ground:

(*a*) Rocky ground or in woods:

To lessen the work in stony ground or when the trench is masked by woods, the depth is diminished and the height of the parapet increased.

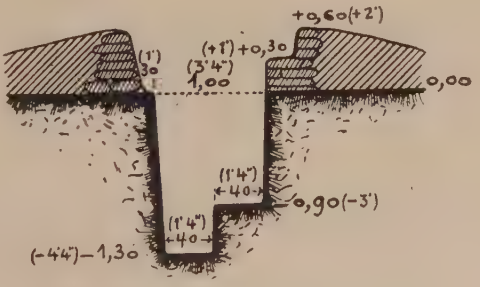


FIG. 37.—Profile on rocky ground or in woods, or increased command required by tactical conditions. This is also the profile to be adopted when the skirmish line hugs the ground and the tactical necessities prevent the careful siting of the work. (See Par. 17–1.)

(*b*) Damp ground:

In order to maintain the trench walls it is necessary to thoroughly revet them with hurdles, expanded metal, wood, sand bags, etc. At the bottom, a board or grating should be placed; and the firing banquette should be made of fascines held together with pegs.

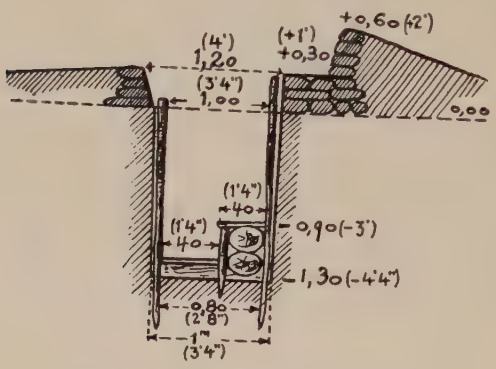


FIG. 38.—Profile on damp ground.

(*c*) Very wet ground:

When the water is very close to the surface, 1 to 2 feet, it is impossible to excavate on account of constant flooding of the trenches. Two ditches should be dug, one in front and one behind the line of resistance, to receive the water. The parapet is constructed by using gabions, fascines, sand bags, etc.

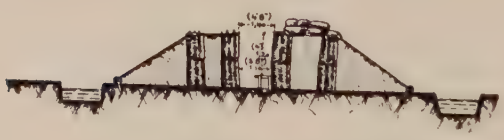


FIG. 39.—Profile on very wet ground.

(*d*) In woods on a hillside:

A layer of logs covered with earth forms the parapet. Drainage is secured with a grating in the bottom of the trench, and drains every ten yards.

25. Shelter for machine guns:

A two-gun emplacement is shown in Fig. 41. The guns are emplaced at an interval of 10 to 15 yards; arranged so that they shall not both be disabled by shell fragments from the same projectile; and to permit repairs, and the protection of the gun crews. The construction is progressive, so that the guns are always ready to fire. The platform is semicircular, with a parapet, first for

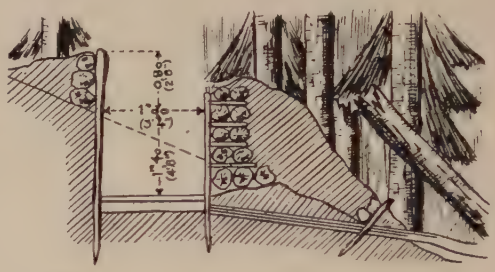


FIG. 40.—Profile in woods on a hillside.

firing lying down, with a parapet one foot high; afterwards for normal firing, with a parapet one foot high and an excavation 1 ft. 8 in. deep for the gun. A ditch, dug progressively, shelters the gun crews; it is first dug to a depth of 1 ft. 4 in. for firing kneeling; then to a depth of 2 ft. 8 in. for firing in a normal position.

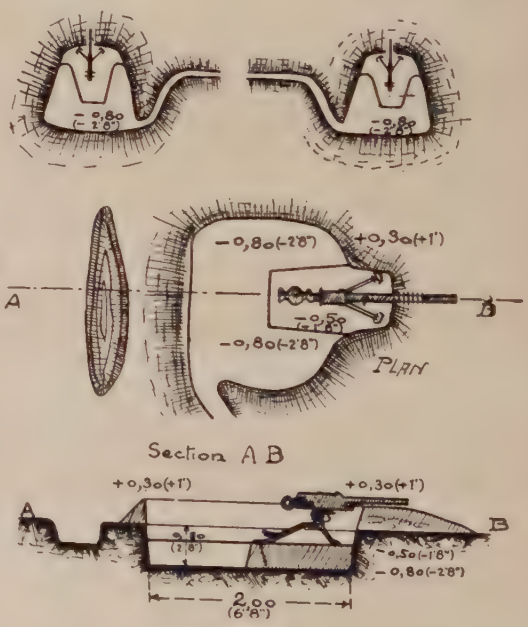


FIG. 41.

26. Individual disposition:

(*a*) Each rifleman arranges the bottom of the trench or the firing banquette (lowering or raising it) to suit his height.

(*b*) He makes a notched loophole in the crest of his parapet.

(*c*) He constructs an arrangement for firing at night; this is verified by the squad or section leader.

(*d*) He makes a recess in the front wall of the trench for ammunition.

(*e*) Concealed shelters are at once constructed for the men on watch, their heads are concealed by bunches of grass, branches, etc.

27. Collective dispositions:

(*a*) Concealment of the trenches:

They should be made as invisible as possible, and their concealment should be completed by treating the front slope of the parapet so that its appearance will correspond to that of the surrounding ground. Crops should be replaced, where disturbed, and carefully arranged; bushes should be planted to hide the parapet, the men on watch, the riflemen, and the commanders. Sod should be preserved and placed on the parapet and parados.

(*b*) Construction of dummy trenches:

Dummy trenches and works should be freely employed so as to deceive the enemy as to the strength of the defender and to scatter his fire. These works should be made slightly more visible than the regular works, so as to attract the attention of the enemy, without causing him to suspect their true nature. It is also necessary to simulate their occupation; and the damage caused to them by artillery fire must be repaired, so that the enemy will not discover his mistake.

(*c*) Drainage:

One of the most important arrangements in the construction of trenches is that for drainage. Besides the accidents and diseases that are likely to occur dur-

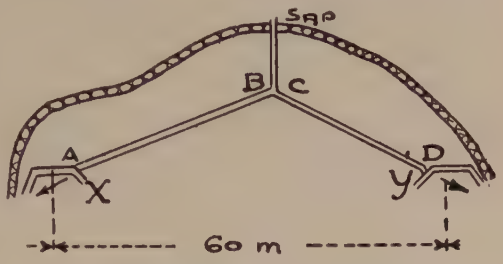


FIG. 42.—A "Bait-trench" can be employed. Two trenches, *AB* and *CD*, are constructed between two works, *X* and *Y*, about 60 yards apart. These trenches should be under enfilading fire. A sap starting from *BC* serves as a bait.

ing a prolonged stay in water, it often happens, that if the drainage is neglected, it will be impossible to occupy the trench during wet weather. To

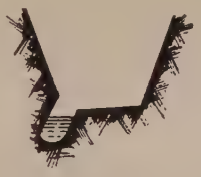


FIG. 43.

drain the water from the bottom of the trench, it is necessary to slope the bottom towards the rear where a drain should be constructed to allow it to

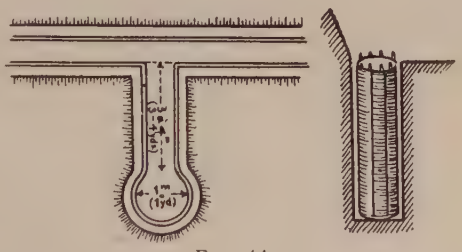


FIG. 44.

run off (Fig. 43). If the bottom of the trench does not have a natural slope along its axis, a slope must be given to the drain. In damp ground, it is merely necessary to receive the water in buried

barrels or pits, filled with filtering material (Fig. 44). The walls of these pits are maintained by sinking in one or more gabions. They are dug at the end of special short communication trenches; the entrance to these trenches should be barricaded.

In less permeable ground, an endeavor should be made to reach a permeable layer by boring with an earth

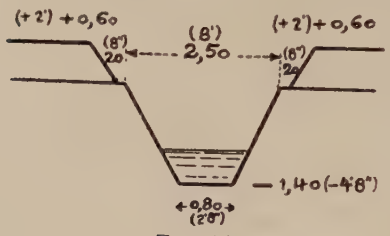


Fig. 45.

auger. The boring will be assisted by successive explosions of detonators, and an enlargement of the hole can be made at the desired depth with a small charge of explosive. In hilly ground, the water can be run off by ditches or even by pipes placed under the parapet. The ditches (Fig. 45) must be large, with sloping sides, to prevent their being ob-

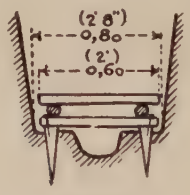


Fig. 46.

structed by the sides caving in. If a permeable layer cannot be reached, or if the volume of water is too great, the water is emptied from the pits with buckets, scoops, etc. Pumps are often used, and to insure their good working a strainer is necessary, and the bottom of the pit should be lined with bricks or tiles.

The water should be run off promptly, otherwise the bottom of the trench becomes muddy, and the muddy water soon renders the pumps useless.

The best and only means of making the bottom of trenches practicable is to install a floor or grating (Figs. 46 and 47) formed of two sills, 2½ to 3 inches in diameter supported on ties which rest on stakes sunk into the ground. On the sills, poles, 2 to 2½ inches in diameter are nailed at intervals of an inch. Instead of poles, boards can be used, but they should be covered with wire netting, to prevent slipping. The floor

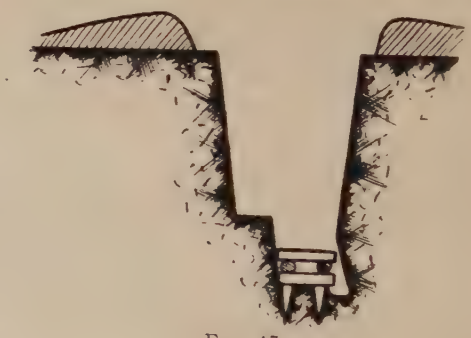


Fig. 47.

should be made in sections, from 2 to 4 feet in length and interchangeable. This work requires a great quantity of timber or lumber, and makes their construction difficult in great lengths.

If timber or lumber is not available, a central or two parallel ditches filled with broken stone can be used in the bottom of the trench, and usually provides good drainage.

(*d*) Revetment:

The trench walls, the seats, benches and steps in soft ground, especially if they are likely to be much used, should be revetted. If possible this should be done when the trenches are first constructed.

When of planks or boards, they should be placed on top of each other, behind stakes, and backed up with earth

(Fig. 48). The stakes should be driven in at the foot of the slope at the desired inclination and at intervals of from one to two yards. Every second or third stake should be anchored to stakes under the parapet by means of wire withes or rope, fastened at about two-thirds of the height of the revetment.

When of branches or brush, the

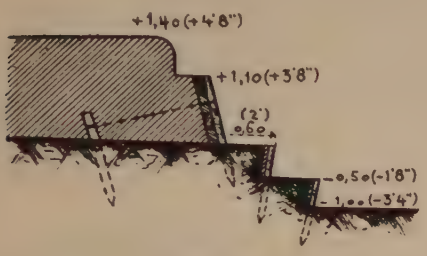


Fig. 48.

branches or brush is heaped up, like the boards, behind the stakes and sufficiently pressed together that the earth at the back does not filter through (Fig. 49). If it is not desired nor possible to anchor the stakes separately, a pole can be fastened along them near the top, and this can be anchored at intervals of from 4 to 6 feet.

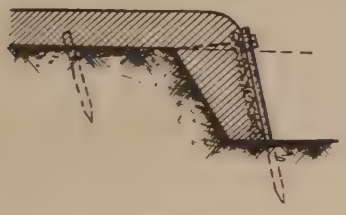


Fig. 49.

When of woven brush, the pickets are driven at intervals of from 1 to 1½ feet: they are temporarily joined together at the top with a pole. The wattles are alternately passed in front and behind the pickets and interwoven. The pickets should be anchored.

When of hurdles, these are especially suitable when used after a work is finished to strengthen it. For method of construction see Engineer Field Manual, page 374. They are placed close together, and the sharpened stakes sunk into the ground and anchored (Fig. 50).

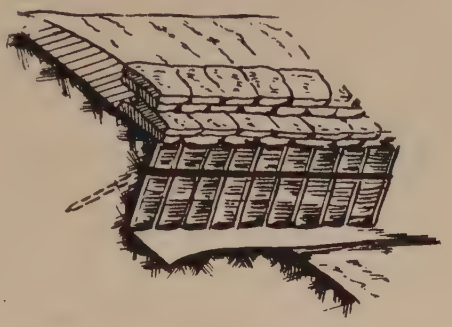


Fig. 50.

When of sod or brick, the sods should be cut to a size of 18 × 9 × 4½ inches. They are laid grass down, like brick masonry. If bricks are used the method of laying them is the same.

When of fragments of hard earth, stones and sand bags, the method of construction is the same as for sod or brick.

When of expended metal, this forms an excellent revetment. It should be supported by stakes about 2½ inches in diameter, at intervals of 18 inches; the stakes should be anchored, and the

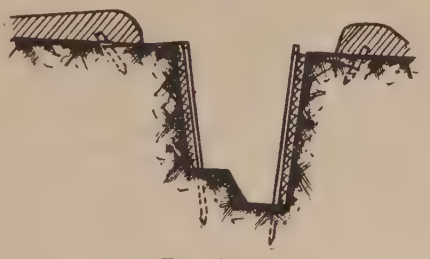


Fig. 51.

metal fastened to them with staples (Fig. 51).

When of fascines, their use is suggested for wide trenches, but they are usually used for making steps.

When of gabions, they are used in

very wide trenches, such as assembly points. They are placed side by side.

(*e*) Steps:

Trenches must be provided with an arrangement that will permit troops to move forward out of the trenches. These steps should be revetted with

FIG. 52.

one or more rows of fascines (Figs. 52 and 53).

Ladders have the advantage of not widening the trench. They are placed

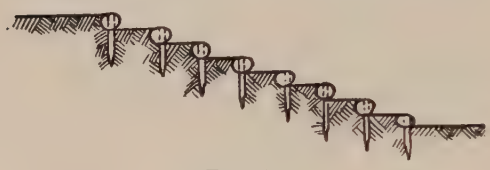


FIG. 53.

vertically against the wall of the trench (Fig. 54).

Ramps parallel to the firing trench may be constructed at the ends of the

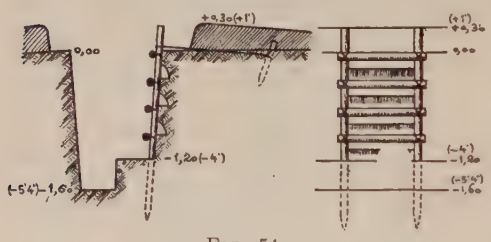


FIG. 54.

branches of a zig-zag communicating trench.

(*f*) Drinking water, a supply of drinking water for the trenches should be provided.

(*g*) Materials, a supply of straw, planks, stakes, and brush serves for protection in inclement weather; and enables the defenders, in the intervals between fighting, to improve the interior organization, revetments, shelters, traverses, etc.

PART IV

TRACE OF INTRENCHMENTS.

28. In the trace of intrenchments, the direction must be frequently changed to avoid enfilade fire. A rifleman shoots perpendicularly to the line of his cover, or at most at 30° to the right and left of this line. Placed at point P (Fig. 55)

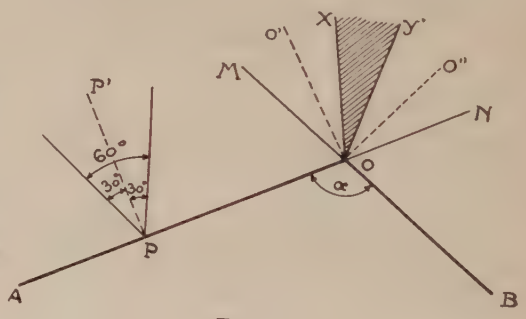


FIG. 55.

his fire will cover, at most, a sector whose angle will be 60°. The angle AOB must be greater than 120°; if AOB is less than 120° the sector XOY will be dead space. This can be shown as follows:

Placed at the point O the rifleman will cover with his fire:

(*a*) The sector of 60° perpendicular to the crest OA.

(*b*) The sector of 60° perpendicular to the crest OB.

These sectors are equally divided by the normal line, hence the angles MOA and NOB are angles of 60°. Therefore:

(*a*) The beaten sectors for riflemen at O are $120° + 120° = 240°$.

(*b*) In order for O and OY to coin-

cide, and the dead space to disappear, the angle AOB must be at least 120°.

When the terrain is such as to necessi-

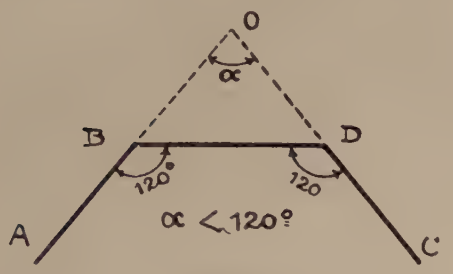


Fig. 56.

tate giving AOB a value less than 120°, the point of AOB should be cut off (Fig. 56), so as to get two larger angles,

Fig. 57.

equal to at least 120°. Moreover, flank fire produces great effect and counterbalances numerical inferiority, so that

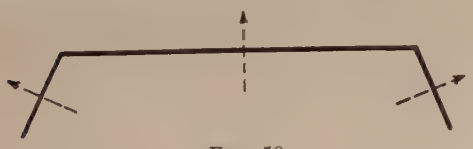


Fig. 58.

traces must be made which will permit this fire.

29. The three types of traces are the

Fig. 59.

lunette (Fig. 57); the flattened lunette (Fig. 58); and the redan (Fig. 59).

30. In tracing intrenchments, combinations of these types are generally adopted, as follows:

(*a*) Indented line (Fig. 60):

(*b*) Redan trace (Fig. 61):

(*c*) Tenailled trace (Fig. 62), if the

Fig. 60.

line of fire is broken, with two adjacent crests mutually flanking each other, the trace is called tenailled.

Fig. 61.

(*d*) Bastioned traces (Fig. 63), if the two flanks face each other and give a reciprocal flank fire, the trace is called

Fig. 62.

bastioned: HGABC is a bastion; AB, EF are faces; BC, ED are flanks; CD is the curtain.

The wings of a trench are always

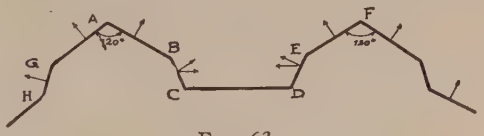


Fig. 63.

terminated by flanks which give a flank fire upon the interval which separates it from its neighbor.

PART V

CONSTRUCTION OF TRENCHES.

31. Composition of working groups: Experience has shown that the best method of dividing up the work (the men being furnished with park tools) is to group the men in pairs; one with

a pick, the other with a shovel; and to prescribe that they relieve each other. The length of the task is determined by laying the picks and shovels down along the trace as shown in Fig. 64.

The length of the task corresponds to the length of fire crest necessary for two men; the workers alternating with pick and shovel have periods of relative rest.

32. Work done by a working group:

A man unaccustomed to digging, in continuous work, can only dig his task a depth of 1 foot an hour; a depth of 2 ft. 4 in. an hour can be quickly obtained by making frequent reliefs and exacting

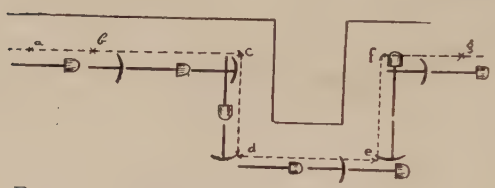


FIG. 64.—Tasks marked out by tools, *a*, *b*, *c*, *d*, *e*, *f*, *g*; stakes marking the trace.

the maximum of effort during the work, so that a standing trench can be constructed in a minimum time of two hours.

The average work of a group of two men not relieved is 1 ft. 4 in. an hour; that is, the deepening will be 1 ft. 4 in. an hour and the standing trench will be completed in a minimum time of three hours.

33. Method of executing the work:

When the tactical situation permits executing the work in safety, the following method is adopted:

(*a*) Establish the trace, place the eye at the level of the interior crest (1 ft.). Mark out the trace with stones or stakes. Mark the points of change of direction (maximum 120°). Mark the position of each traverse, between squads (minimum thickness of traverse, 2 yards).

(*b*) Deploy the working party along the trace by such method as the tactical conditions demand.

(*c*) Place the rifles and packs on the rear side, the rifles in reach.

(*d*) Mark out the tasks on the ground with a pick. Mark out the traverses in the same manner.

(*e*) Strip the sod from the width of excavation (3 ft. 4 in.) and rapidly construct with it a mask or small parapet, with a steep slope on the rear; raise it to 1 ft. 4 in. (The piling up of the earth on it will reduce it later to 1 ft.)

(*f*) Dig as vertically as possible. The slope must not exceed $^{10}/_{1}$, except around the traverses, where it may be increased to $^{15}/_{1}$ or $^{20}/_{1}$. As soon as the parapet affords sufficient protection, the workers, designated beforehand, make the traverses. They are commenced at the two ends.

(*g*) Make a parados as soon as the depth exceeds that for a kneeling trench (2 ft. 4 in.).

(*h*) Conceal the trench by means of sod taken previously from the sites of the parapet and parados and give to these the appearance of the original ground.

(*i*) Arrange communications masked from view (by brush, etc.).

(*k*) Proceed to the individual and collective arrangements.

34. Night work:

When circumstances render night work necessary, special dispositions must be made:

(*a*) Except where absolutely impossible, stake out the trace before complete darkness.

(*b*) If the trace can only be made at night, utilize visible reference points (white paper, white stones, white tape, pocket lamps, etc.).

(*c*) For the distribution of the work

and commencement of it, employ the same principles as for day work.

(*d*) Avoid, except the inevitable noise of the tools, anything that may reveal the presence of the workers (cigarettes, conversation, etc.).

(*e*) Protect the workers by patrols stationed to the front.

35. Methods of measuring:

When the work is done in safety, the greatest care should be taken to make it as accurately as possible. It is particularly necessary to see that the typical dimensions are followed out to within 2 inches, and these should be checked with rods upon which these dimensions are marked, or by comparison with the following lengths:

4 in. Width of the hand.

6 in. Width of the blade of the Ordnance portable intrenching shovel ($6\,^{11}/_{16}$ in.).

8 in. Width of the blade of the E.D. small size shovel in regt. tool wagon ($8\frac{1}{4}$ in.).

1 ft. Length of the blade of the E.D. small size shovel (11 in.).

1 ft. Length of the foot of a man.

1 ft. 8 in. Total length of the Ordnance portable intrenching shovel ($21\frac{1}{2}$ in.).

1 ft. 8 in. Total length of the bayonet (20.6 in.).

2 ft. 8 in. Total length of the E.D. pick mattock in regt. tool wagon (33 in.).

5 ft. Total length of rifle with bayonet fixed.

These lengths should be thoroughly taught to the infantryman, for they are necessary for the proper construction of intrenchments; and he will know that 1 ft. 8 in. is not 1 ft. 4 in. and he will always have the dimensions of his firing trench, communication trench, and shelter in his mind; he will know beforehand the length of his task, and will not dispute over its execution.

CONCLUSION.

36. It is difficult to realize what the organization of a fortified point costs in methodical labor and blood, when it is accomplished under the fire of hostile artillery, and small arms. Under the direct rifle and machine-gun fire, and the intermittent shower of shell and shrapnel, the working party continues, making as little noise as possible and hiding as best they can, to dig into the ground, place the stakes, put up the barbed wire, and strengthen the advanced trenches. There are no words to describe the long night hours during which the workers complete, in this way, the system of fire trenches, arrange for sure communication with the rear, and place the obstacles which the enemy will next day encounter. Suddenly a machine gun opens fire; all lie down and crawl into their holes. The alarm has been given in the hostile position; the fusillade commences, the rockets go up; great lights go up and light the ground. The hostile look-outs redouble their vigilance. It is necessary to wait until the enemy's activity ceases, and then again the workers glide to their posts to fix the stakes, and, tirelessly, to complete the protecting system.

CHAPTER III

THE TRENCH WEAPONS.

The present war in Europe has shown that, when the direct fire of powerful modern arms becomes ineffective, the combatants return to the weapons and machines of ancient warfare. Grenades, abandoned for a hundred years, and catapults, slings, onagers, etc., are now in use. Grenades appear to have been first used in 1516, at the siege of Arles. The city was threatened with investment; a great quantity of grenades which the defenders were to use in throwing from the top of the walls among the assailants were sent there. The grenades were made of glass, globes, jars, kegs, and firepots. In 1677, at the siege of Stettin, the defenders used grenades attached to rods, which were fired from muskets, although the regular method was to throw them by hand or by means of a shovel. Regiments of grenadiers were formed, but, at the end of the seventeenth century, as the fire of infantry became predominant, grenades were given up.

Machines, such as catapults, slings, onagers, etc., are known to have been used eight centuries B.C. The Bible tells us that the walls of Jerusalem were provided with "machines constructed by a very wise engineer to throw bolts and large stones."

At the present time rapid-fire weapons having forced opposing armies to entrench, warfare has become a long siege with frequent sorties. Under these conditions, the grenade has become very useful, both on the offensive and the defensive. Its effects are specially useful at the moment of assault, when by its deadly explosions, following the violent artillery preparation, it completes the demoralization of the defenders of the hostile trenches.

2. Grenades may be classified, according to their range, into:

(*a*) Hand grenades, with range of 30 to 35 yards. These may be explosive grenades, suffocating grenades, poison-gas grenades, tear-producing grenades, incendiary or smoke-producing grenades.

(*b*) Rifle grenades, with a range of 80 to 200 yards.

(*c*) Grenades, or bombs, for trench weapons.

PART I.

HAND GRENADES, RIFLE GRENADES, AND TRENCH WEAPONS.

3. *Explosive hand grenades* are made up of a case containing a certain quantity of explosive. As regards ignition, they are divided into two types: percussion and time. Some are a combination of the two, and have both time and percussion fuses. As regards tactical employment, grenades are also divided into two classes: defensive, relying upon fragments of bullets; and offensive, relying upon the blast of high explosive.

4. *Handling and Transportation.*—Great precautions should be taken in the handling and transportation of grenades. They are always dangerous,

especially when handled by men ignorant of their make-up or assembly. For transportation, they should be carefully packed, with the fuses in separate boxes. They should be protected from dampness, and the fuses should be kept

FIG. 1.

entirely separate from the explosive cases. The safety devices should never be removed until the moment of throwing.

5. *Grenade Throwing.*—The instructions for priming and throwing of each type should be carefully followed. Grenade work should be rapid, but without hurry, with calmness and coolness. The grenade should be thrown immediately after its fuse is ignited, even when there is some doubt whether it has been properly ignited. Men should be carefully and thoroughly trained in grenade throwing. Their use by trained men greatly reduces the risk of accidents and the expenditure of grenades. The proper method of throwing is shown in Figures 1 to 5.

Initial position (Fig. 1): Aim at target with the extended left arm. With the grenade in the right hand, the right arm falls naturally alongside the body. The shoulders, the extended left arm, and the target should be in the same vertical plane.

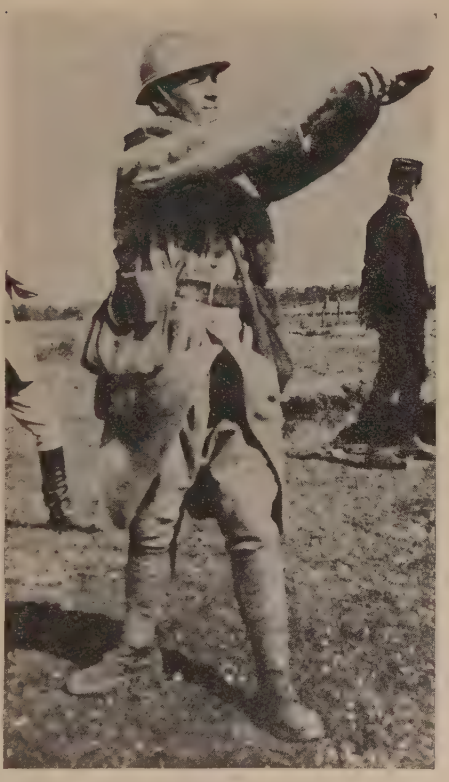


FIG. 2.

First motion (Fig. 2): Left arm maintained in the direction of the target. Carry the grenade to near the left hand for igniting.

Second motion (Fig. 3): Left arm maintained in the direction of the tar-

get. Carry back the right arm by swinging it in the vertical plane, eye following the grenade to avoid hitting it against anything in rear. Extend the left leg, bending over right leg.

Third motion (Fig. 4): Look again

FIG. 3.

at the target, or at the aiming point if there is one in the trench.

Fourth motion (Figs. 5-a, 5-b): With the right arm, describe an arc of a circle in a vertical plane, the right shoulder and the body following the movement of the arm. Extend the right leg, bend the left leg. The left arm is swept vigorously through the air following the left shoulder, which is refused.

The grenade thrown vigorously in this way will go in the direction toward which the left arm is aimed. The right arm acts like a catapult. It should never be thrown horizontally nor with the elbow bent. The fire must be plunging. The duration of the execution of the four motions is about two seconds.

6. *Training in grenade throwing* should have the following objects in view:

(*a*) To teach every infantry unit so that it can rapidly undertake a grenade fight when circumstances demand it.

(*b*) To train selected squads to execute sudden grenade attacks.

FIG. 4.

The squad should be organized into a squad leader, two riflemen, two grenade throwers, three ammunition bearers. It may be followed by a chain of men to pass forward ammunition, and a squad of pioneers. As soon as

the first line of the enemy is reached, the grenade fighting commences. In the trenches and approaches there will always be angles and traverses that must be cleared of the enemy.

7. *The typical method of trench clearing* is shown in Fig. 6. The enemy

FIG. 5A.

must be driven back step by step, and a formation adopted that will minimize the losses caused by his grenades. A rifleman (f^1) acts as a point, stops the enemy's approach, and protects the grenade throwers. Two grenade throwers (1^1, 1^2) throw grenades to points 1, 2, 3, then to 1′, 2′, 3′, always beyond the defiladed spaces, and so as to assure a constant and progressive clearing out of the trench. The squad leader (Ch) directs the fight, corrects the fire, organizes the relief of the grenade throwers and of the ammunition bearers, superintends the ammunition supply, and prepares to defend his ground foot by foot if progress becomes impossible. The three ammunition bearers (p^1, p^2, p^3) are stationed several paces in rear so that they can get out of the way without stumbling over each other. They pass up the grenades in bags. A chain of men passes up the ammunition from the nearest grenade depot. A squad of pioneers (P) is stationed close in rear of the ammunition bearers, ready to construct a barricade or to demolish those of the enemy. They are supplied with shovels, picks, empty sand-bags, bombs, and explos-

FIG. 5B.

ives. They may also have rifle grenades to interfere with the enemy's ammunition supply, and one or two men with automatic rifles to defend the barricades.

The grenade squad must preserve silence and observe carefully all noises coming from the enemy. When the

leading group decides that the enemy is overwhelmed, the first rifleman creeps forward carefully in the smoke, peeps around the angle, and signals to his comrades. Thus they progress from turn to turn and from traverse to traverse. The squads must not bunch up; not more than three men should be together; they must advance prudently and watch for traps, fougasses, etc. The long, straight portions of trench are often enfiladed by rifles or machine guns placed in the traverses. The enemy also hides at the end of a blind lateral trench, the entrance of which is masked by a piece of painted canvas. If the advance is made too rapidly, the enemy comes out of his hiding place behind the grenade squad and cuts it off.

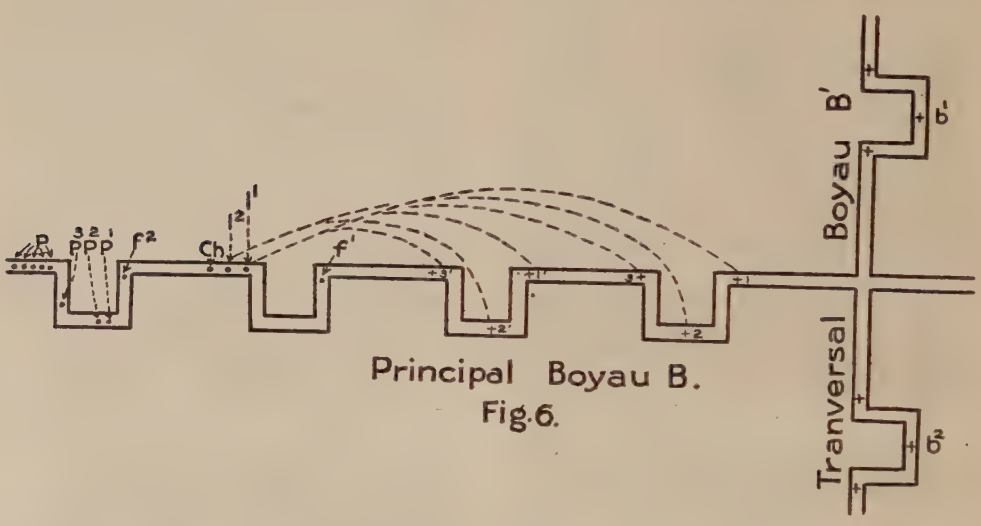
When a lateral trench is reached (B'), several grenades should be thrown in both directions, at least three at each traverse, as shown at b^1 and b^2. It should be explored and barricades established and guarded if it is not considered necessary to continue farther along it.

All the members of a grenade squad should be able to perform all the different duties and be ready to undertake them at once when ordered by the squad leader.

On open ground, grenade squads march in the formation of patrols.

8. *Rifle Grenades.*—A well-directed fire of rifle grenades demoralizes the enemy and causes much more severe losses than an artillery bombardment. The enemy's trenches should be carefully observed to ascertain the points where men are likely to be stationed, such as sentry posts, entrances to shelters, intersections of approaches, etc. Rifles clamped in racks should be directed at these points, in order that a grenade may be fired at them immediately upon the indication that they are occupied. Fire should be continued night and day at these points. In spite of the almost complete concealment of the enemy, his dispersion, and his protection by shelters, it will be possible to inflict appreciable losses upon him by a constant rifle grenade fire, directed at well-chosen points.

A well-directed rapid fire by small, perfectly-trained detachments, upon an enemy assembled for attack, or upon



Principal Boyau B.
Fig.6.

known and registered points of the communications, at the hour of changing reliefs, should give excellent results.

In assaults, the employment of men carrying rifle grenades should be closely coördinated with the other elements of the attacking lines.

In trench clearing, the fire of rifle grenades should be carefully executed by the supply squad which follows immediately in rear of the squad of grenade throwers. This fire should interfere with the enemy's supply and bar his lines of retreat.

The range of rifle grenades is about 200 yards at an angle of 45 degrees. The angle of fall is large, and makes their fire against trenches very effective. The rifle may be fired from the shoulder or from a special rack.

9. *Trench weapons* are divided into two general classes, viz., *high power,* which are handled by the artillery, and *low power,* whose propelling power is powder, compressed air, or springs handled by the infantry. Only the low-power weapons will be discussed. These are organized into batteries of four to six pieces and attached to battalions. The assignment of the weapons among the different battalions of the regiment is made so as to concentrate the maximum number at the most important points, with a view to the results to be obtained.

10. *Tactical Employment of Trench Weapons.*—Low-power trench weapons have a range which varies from 50 to 300 yards, according to the propelling charge and the setting of the time fuses. They are not very effective against matériel, but are very effective against personnel sheltered behind cover which gives protection from rifle fire.

On the offensive, they may be employed:

(*a*) Against works, such as machine-gun emplacements, nearly demolished by the artillery preparation, which the enemy, having been sheltered in deep bombproofs from this fire, has reoccupied.

(*b*) In parts of the front adjacent to those from which the offensive has started, with a view to supporting the attack in conjunction with the infantry remaining in the trenches and which has been reduced to a minimum; and in order to neutralize the corresponding hostile front and prevent hostile action against the flank of the attacking troops.

(*c*) After a successful attack, by moving forward to the captured front, and there rapidly organizing emplacements for its defense or for action against portions of the new hostile front which are too near to permit artillery fire against them, without danger to our own troops.

On the defensive, trench weapons may be employed:

(*a*) On parts of the front held by a few men where the effects of these weapons will compensate for the small garrison.

(*b*) On parts of the front which are close to hostile listening posts, small posts, or advanced works which threaten the first line.

(*c*) Behind the first lines, close to the second or third line of a position, with a view to making untenable parts of a line captured by the enemy.

11. *Location of Emplacements.*—The location depends primarily upon the objective. The fire has the most effect when it is oblique; but, in the first line, observation of the fire is easiest and the fire is more accurate. The emplacements are therefore located near the first line, preferably in parts of the line

most difficult for the enemy to reach, such as re-entrants, defiladed points, etc. Three or four alternative emplacements should be constructed on each line of trench; and the emplacements for a battery should be divided by traverses into positions for a platoon of two guns.

12. *Fire of trench weapons* is divided into four classes:

(*a*) Destructive fire: Against listening posts, small posts in course of construction, and blockhouses already damaged. This fire must be rapid.

(*b*) Offensive fire: At the time of the preparation for an attack, by adding to the artillery fire.

(*c*) Defensive fire: Rapid fire upon the parallels of an enemy, preparing for an attack; rapid, sudden, and unexpected fire at opportune times upon trenches and approaches captured by the enemy.

(*d*) Firing in periods of calm: This must be very rapid at any time that the enemy appears negligent; such as a working party arriving in a trench and observed from an elevated observing station; during a calm following a violent fight; during the hot hours of the day, during rain, during dark, silent nights, etc.

The commander of a battery of trench weapons must be constantly on watch and alert; and he must coöperate to the highest degree to give an aggressive attitude to the garrison of a sector during the periods of calm.

Trench weapons may throw either hand grenades or special projectiles.

PART II.

PRINCIPLES OF THE FIRE OF TRENCH WEAPONS.

13. *Definitions.*

The *trajectory* is the curve followed by the projectile (Fig. 7).

The *range* is the distance *AB* between the weapon (*A*) and the point of fall (*B*), (Fig. 7).

The *angle of fire* is the angle "a" formed by the direction of the weapon

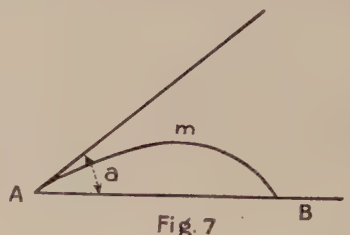


Fig. 7

with AB, which joints the weapon and the target (Fig. 7).

The *angle of site* is the angle which this line makes with the horizontal (Fig. 8).

The *inclination* of the trench weapon

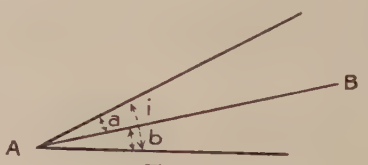


Fig. 8

"i" is the sum of or the difference between the angles of fire and of site, according as *B* is above (Fig. 8) or below (Fig. 9) the horizontal.

The *angle of fall* is the angle that the trajectory makes with the horizontal at

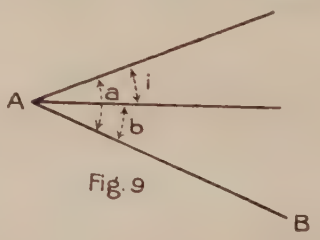


Fig. 9

the point of fall. It is usually slightly greater than the angle of fire.

The *initial velocity* is the velocity of the projectile at the muzzle.

The *plane of defilade* is the plane passing through the upper part of the mask or cover which protects the

emplacement and through the point from which it is desired to be defiladed. Points situated above this plane are visible from the latter point, those below are hidden from it.

14. *Classification of fire.*

According to the angle of fire:

(a) *Direct fire:* Corresponding to a flat trajectory, for which the angle of fire is less than about 15 degrees.

(b) *Plunging fire:* Corresponding to the curved trajectory, for which the angle of fire is greater than 15 degrees.

(c) *Vertical fire:* If the angle of fire is greater than or equal to 45 degrees.

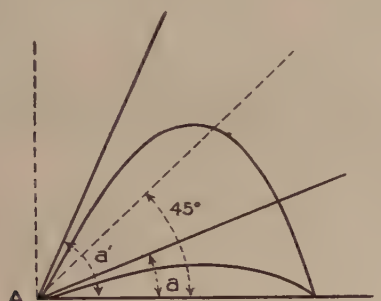


Fig. 10

With a given initial velocity, there are two angles of fire which permit hitting the same target. These two angles of fire, in the case of an angle of site equal to zero, and not taking into account the resistance of the air, correspond to two directions symmetrical with respect to the line at 45 degrees, so that the sum of the two angles is 90 degrees.

Example: If the point *B* (Fig. 10) can be reached from the point *A* with an elevation of 20 degrees, the other angle permitting a hit on the same point with the same initial velocity is 70 degrees. In reality, the movement of the projectile being made through air, a slight correction must be applied to the above rule; this correction depends upon the projectile employed.

According to the direction of fire:

(a) *Direct fire:* Normal to the crest of the hostile entrenchment.

(b) *Oblique fire:* Oblique to the crest of the hostile entrenchment.

(c) *Enfilade fire:* Parallel to the crest of the hostile entrenchment.

(d) *Oblique reverse fire:* Oblique to the crest and coming from the rear.

(e) *Normal reverse fire:* Normal to the crest and coming from the rear.

15. *Classification of Trench Weapons.*—Trench weapons generally use plunging fire; they may be divided into two general classes, viz.:

Of constant initial velocity:

(*a*) Powder charge constant, in the case of mortars.

(*b*) Constant tension of springs, in the case of spring weapons.

(*c*) Constant air pressure, in the case of pneumatic weapons.

Variation in the range is obtained by variation of the angle of fire. As there are two angles of fire that correspond to the same range, the greater of the two is generally used to obtain plunging fire. The variation of the angle is not proportional to the variation of the range. To determine the range, having given the angle of fire, or conversely, the firing table for each weapon is used. This may be in the form of a table from which the range may be read off for any angle; or in the form of a curve, where the abscissæ indicate the ranges and the ordinates the corresponding angles (Fig. 11). Example: The range of 75 meters corresponds to the angles of 20 and 70 degrees.

In this class are included trench weapons which are able to give to the projectiles a limited number of initial velocities, by changes in the charges or pressures. The above rules are applied to each of the initial velocities. The firing tables are of double entry. The

graphical firing tables contain several curves, each corresponding to a well-determined initial velocity.

Of constant angle of fire; the initial velocity is then variable:

(*a*) Powder charge variable.

(*b*) Tension of spring variable.

(*c*) Air pressure variable.

A single initial velocity corresponds then to a given range. It is generally

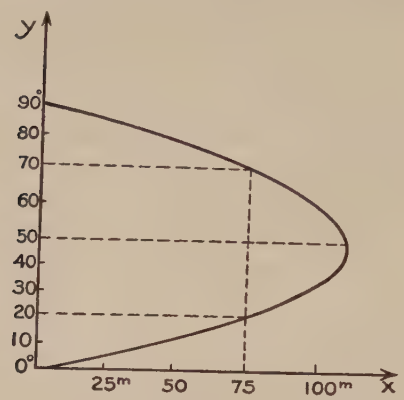


Fig. 11

given by a firing table in tabular form. Weapons of this character generally permit two inclinations: usually 45 degrees and 60 degrees. To each of these inclinations corresponds an initial velocity given by the firing table.

16. *Adjustment of Fire.*—The adjustment of fire consists in finding the elements which cause the projectile to hit the target. It is divided into two operations: adjustment in direction and adjustment in range.

(a) *Adjustment in Direction.*—Trench weapons do not usually have devices for adjustment in direction. A device may be improvised as follows: Trace on the ground, with their intersection directly under the vertical axis of rotation of the weapon, two right lines perpendicular to each other, one of which is parallel to the trench; divide each of the right angles into 16 equal angles (Fig. 12). A peg should be placed at each division at the same distance from the center, and should be numbered from 0 to 32, as indicated in the figure. Each of the angles thus obtained equals one-tenth, *i.e.*, the angle that subtends 10 yards at a distance of 100 yards, or 5 yards at a distance of 50 yards. When the scale is to be used for some time, it should be made on a plank platform.

(b) *Adjustment in Range.*—This is obtained by variation of the angle of fire or of the elements which vary the initial velocity. A constant use of the firing table is necessary. The range is obtained by bracketing the target between two shots, one short, the other long, corresponding to two ranges, slightly different. As trench weapons have short range and are very accurate, a very small bracket may be used, from two to five yards. The chief of the piece or observer must give for each modification the new elements of fire for range (angle of fire, charge, pressure, tension) according to the reading of the firing table.

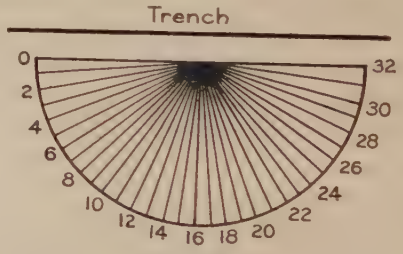


Fig. 12

17. *Principles of observation.*

(a) Observation for Direction.—In order to accurately observe the direction and amount of deviation in azimuth of a shot, the observer must be in the plane of fire of the weapon. If not in this plane, considerable errors may be made, when the error in range is great; as an

error in range may be taken for one in direction.

(b) Observation for Range.—The adjustment of the fire for range depends upon an accurate observation of the points of fall of the projectiles. If the smoke of the explosion hides the target, the range is too short. If the terrain on which the target lies slopes toward the piece, the shot is short or long according as the point of fall is seen under or over the target. When it is difficult to observe errors of range from a point in the plane of fire, these errors must be determined by an observer placed well to one flank of the piece.

PART III.

DESTRUCTION OF UNEXPLODED GRENADES.

18. After each drill in throwing loaded grenades, those that have not burst should be destroyed. If the grenades have time fuses, at least ten minutes should elapse from the time the last grenade was thrown before anyone is allowed on the range to hunt for unexploded grenades. These grenades may then be considered harmless, and they may be gathered and placed in a small pit and exploded with a small charge of high explosive placed in the center of the pile. The detonation can be made more complete by placing several shovelfuls of earth over the pile of grenades. Before the charge is exploded, the personnel should be under shelter.

If the grenades have percussion fuses, it is dangerous to move them, and they should be destroyed with a small charge of high explosive placed in contact with them and covered carefully with a shovelful of earth. In case of a misfire, ten minutes must elapse before the operation is repeated.

It must be absolutely forbidden for anyone to try to unprime unexploded grenades by unscrewing the fuse.

CONCLUSION.

19. In all sectors of the Western Front in Europe, the grenade throwers have shown great skill and the advantage of thorough instruction.

In one instance, the French succeeded in occupying the entrance of one of the principal avenues of a village; the Germans held the rest. The houses that lined this avenue were practically destroyed; some pieces of the walls alone remained standing. The Germans, skilfully hidden in the shelter of the ruins, had stopped the French charge, and had brought up a field gun and placed it behind a barricade so that it enfiladed the avenue. It was impossible to destroy the gun with artillery, so that grenade throwers were sent forward to destroy it. After two hours of slow and stealthy approach under constant rifle fire, they succeeded with several well-placed grenades in killing the cannoneers just as they were loading the gun, and were able to capture it. The riflemen who followed them were then soon able to capture the rest of the avenue.

During the numerous attacks at Verdun the grenade throwers covered themselves with glory. The engagements inside Fort Douamont were among the most exciting and most tragic of the war. When the details of the fighting at Vaux, Thiamont, and Fluery are known, the great value of the work of the grenade throwers will be appreciated.

CHAPTER IV

PROFILE AND EXECUTION OF DELIBERATE FIELD WORKS.

1. *General Principles.*—Field fortification is divided into hasty or light, and deliberate. The directing principles are the same in both cases. The first develops into the second when the stay in one position is long enough to permit improving and completing the work executed at first in haste.

The strengthening of light field works, which were constructed under conditions explained in the preceding lecture, will have for its object:

(1) To increase the resistance to hostile artillery.

(2) To increase the protection offered to the occupants.

(3) To create sheltered communications: (*a*) With the elements of observation and advanced defense. (*b*) With the neighboring elements of the firing line. (*c*) With the rear, for supply, evacuations, command posts, reinforcements, etc.

(4) To place under shelter the personnel and apparatus for observation, illumination, and communication.

(5) To create shelters for the material, arms, ammunition, and emplacements and shelters for machine guns and trench weapons.

(6) To better living conditions in the trenches.

(7) To make the approaches to field works very difficult for the enemy.

PART I

INCREASE OF RESISTANCE OF TRENCHES TO ARTILLERY FIRE

2. *Deepening the Trench.*—The first step in strengthening the trench is to deepen and widen it. In this way are obtained:

a. The earth necessary for the strengthening of the parapet.

b. The space necessary for the revetment of the walls of the trench.

A minimum depth is 6 feet 8 inches; width at the top, 4 feet 8 inches; width at the bottom, 3 feet 4 inches.

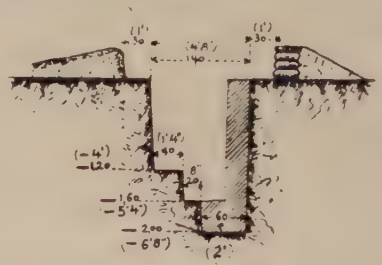


FIG. 1.—Deepened trench.

The work is progressive—from the rear part of the complete trench, the part hachured in the drawing is excavated. An intermediate step permits the rifleman to reach the firing banquette.

3. *Increasing the Strength of the Parapet.*—There is no longer any difficulty about increasing as much as possible the thickness and height of the parapet which protects the riflemen. Its strengthening is secured by the employment of sand-bags and by the construction of loopholes whose base should be at a maximum height of 5 feet.

4. *Revetment of the Walls of the Trench.*—Resistance to the destructive effects of fire on the trenches should be increased by revetting the walls of the trench. This can be done in several ways: from the light revetments described in the preceding lecture to the construction of walls of reinforced con-

crete (Fig. 3). The proportions of cement, sand, and gravel or broken stone most used are (*a*) one of cement, two of sand, and five of gravel or broken stone; and (*b*) one of cement, three of sand, and six of gravel or broken stone. Steel rods are used for the reinforcement.

Fig. 2.—Arrangement to cause projectiles to burst.

5. *Arrangements to Cause Projectiles to Burst.*—At night narrow trenches may be dug in the parapet, which are filled with a layer of logs. These will cause a premature burst of projectiles which hit in front of it (Fig. 2).

6. *Concrete Revetment.*—By gradually increasing the amount of concrete, the work approaches the character of a

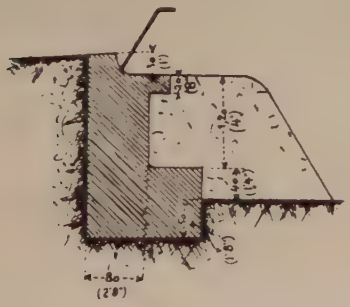


Fig. 3.—Concrete revetment.

permanent fortification. The interior walls may be revetted with concrete walls, and concrete traverses may be constructed at intervals of two or three yards. Steel loopholes may be placed, and a recess constructed in the front wall which will form an excellent shelter (Fig. 3).

Part II

Increase of Protection for the Personnel

7. *Protection of the Personnel in the Firing Trench.*—The trace should be a broken line, with traverses, splinter proofs, individual niches for the riflemen, and bomb-proofs with armored roofs.

8. *Traces of Broken Lines.*—The greatest danger against which it is necessary to protect the personnel is that of enfilade fire. The best means of

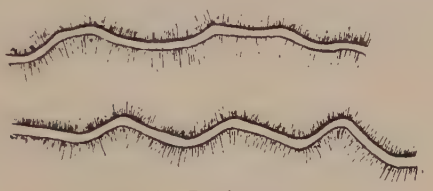


Fig. 4.—Broken trace.

protecting is to avoid traces of long, straight lines. When under fire it is not always possible to construct traverses at first, and they must often be constructed later. They may be replaced by:

a. Using a trace of a broken line (Fig. 4).

b. Using an indented trace (Fig. 5).

The perpendicular distance between the axes of the longer straight elements should not be less than 5 feet, and these elements should not be longer than 6 yards.

Fig. 5.—Indented trace.

9. *Traverses.*—The best method for defense against enfilade fire is to localize the effect of projectiles by employing traverses (Figs. 6, 7, and 8).

To give protection against the effect of heavy artillery, the traverse must be at least 2 yards thick on top. In places exposed to direct fire, this thickness

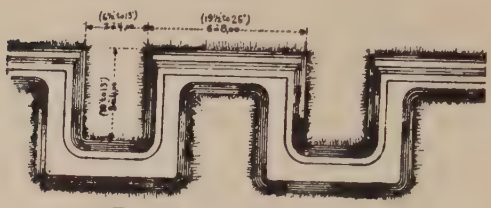


Fig. 6.—Traversed trace.

must be increased to 3 or 4 yards, depending upon the character of the soil. In depth, the traverse should project at least one yard beyond the face of the rear wall of the trench. The interval between traverses should be from 6 to 8 yards. In exposed places this interval should be reduced to 4 or 5 yards.

10. *Traverses Constructed after the Completion of the Trench.*—If practicable the traverses should be constructed simultaneously with the trench. If, however, the trench has been made without traverses, they should be con-

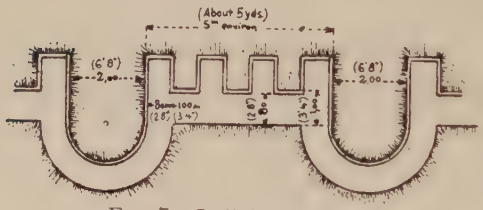


Fig. 7.—Individual niches.

structed as soon as practicable by obstructing a part of the trench with sandbags, boxes, barrels, gabions, etc., and a passage should be opened around them to the rear. When the traverses are wide, berms should be constructed on the sides, and a firing banquette should be constructed for flanking fire. This is especially necessary on the flanks of a trench and at the exits of a communicating trench.

11. *Individual Niches.* — In places particularly exposed to enfilade fire, individual niches for riflemen should be constructed between the traverses (Fig. 7).

These afford efficient protection against enfilade fire. They are often constructed in old trenches which have been damaged by projectiles or bad weather.

12. *Splinter Proofs.* — In trenches greatly exposed to artillery fire, splinter

Fig. 8.—Perspective of traversed trench.

proofs should be constructed between the traverses. Their roofs should be just thick enough to protect against shell fragments and shrapnel, and they should be short so as to reduce as little as possible the length of the fire crest. They may be constructed of fascines, sand-bags, or gravel and sand between two layers of planks.

Fig. 9.—Splinter proof.

A form of splinter proof which can be readily constructed is shown in Fig. 9. It is made by driving stakes into the

parapet; on these are placed poles and a layer of earth a foot thick. If steel rails are available they may be used instead of the stakes and poles, and afford much better protection. The supporting rails should be braced by props set in the rear berm of the trench, and loopholes should be constructed.

The trench may be covered as shown in Fig. 10. Parts of the trench should

Fig. 10.—Covered trench.

be left uncovered—one for a section of each company—to enable troops to leave the trenches for an attack. The dimensions of the trench are not modified.

If sufficient logs are available, a double roof may be constructed (Fig.

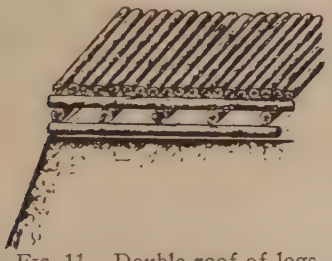


Fig. 11.—Double roof of logs.

11). Two layers of logs with a foot of earth between form a cover capable of resisting a 150 mm. (5.9 in.) high explosive shell.

A covered trench with an open passageway (Fig. 12) may be constructed from the standing trench by widening the trench. It forms an excellent continuous shelter and does not interfere with an advance or render the defenders

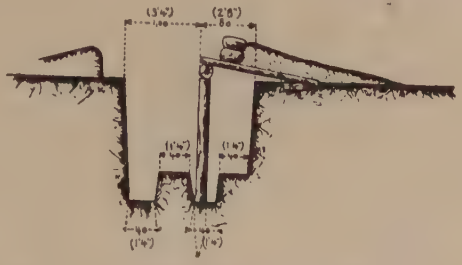


Fig. 12.—Covered trench with passageway.

liable to be bottled up, as does the covered trench shown in Fig. 10. The protection can be increased by increasing the number of traverses and making individual niches of gabions, fascines and sand-bags (Fig. 13).

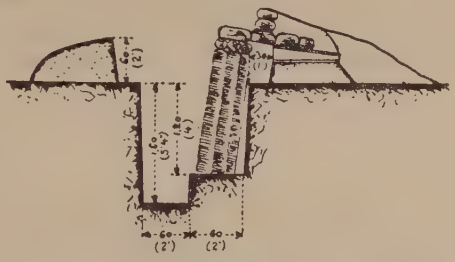


Fig. 13.—Covered trench with individual gabion traverses.

13. *Head Cover.*—Head cover is the term applied to any horizontal cover which may be provided above the plane of fire. It is obtained by notching or loopholing the top of the parapet.

(1) *Notches.*—When the relief of a trench is too great for a man to fire standing, or when the height of the parapet is more than a foot above the level of the ground, notches should be made in the parapet. The simplest way to make these and give support to their sides and make them the least visible is to arrange sand-bags on top of the parapet as shown in Fig. 14.

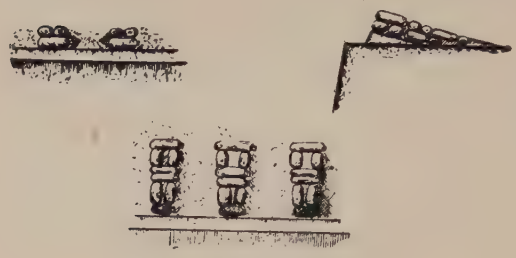


Fig. 14.—Sand-bag notches.

(2) *Loopholes.* — When overhead cover is used, loopholes are necessary. They may be collective, as shown in Fig. 10, or individual, constructed of sand-bags, wood, steel, hurdles, etc.

Fig. 14a.—Loopholes of sand-bags.

a. Loopholes of sand-bags.—These can be rapidly constructed, afford good protection and are easily concealed. Their strength can be increased by using planks or light poles under the sacks. About sixteen sand-bags are required to a loophole.

b. Steel and wooden loopholes.—These should be prepared in the rear. They require 9 to 10 square feet of

Fig. 15.—Side of a wooden loophole.

boards, 1 to 1½ inches thick, and 40 nails, 2 to 3 inches long. Two carpenters can make a loophole in an hour. Steel plates decrease the visibility and greatly increase the protection. They should have an opening with a movable cover, and should be placed at the rear of the loophole.

c. Loopholes of hurdles. — When boards or steel plates are not available, loopholes may be constructed or hurdles or woven brush. The dimensions should be the same as those shown in Fig. 16.

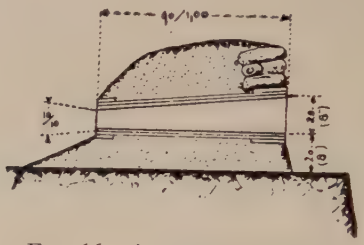


Fig. 16.—A wooden loophole.

d. Loopholes of steel rails.—These may be constructed of two pieces of rail, not more than a foot long, placed vertically at an angle to each other, with

Fig. 17.—Loopholes of steel rails.

an interval of an inch or two for firing through. The webs of the rails may be reinforced with 3-inch wooden strips to prevent bullets penetrating, and blocks should be used to hold the rails apart. Pieces of rail may also be used to form a narrow, horizontal opening, an inch or two high.

Fig. 18.—Loophole of folding gabion.

e. Loopholes of folding gabions (Fig. 18).—The folding gabion is made of boards hinged together. They can be formed into parallelograms of different angles and thicknesses and are very convenient for making loopholes.

(3) *Shields.*—These are of two kinds, the portable and the parapet.

a. The portable shield (Fig. 19) is intended for fighting in the open, but may be used on a parapet. It is made of special steel, 20 inches square and .33 inch thick; weighs 33 pounds, and will resist an ordinary bullet at short range.

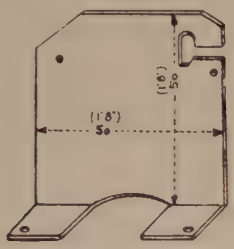


Fig. 19.—Portable shield.

It has a loophole, two folding feet, and four holes for the attachment of a carrying cord. The cord can be arranged so that the shield can be carried on the arm when under fire, or on the back when not under fire.

b. The parapet shield is specially made for use as a loophole, but it can be utilized when crawling forward (Fig. 20). It is made of special steel, 2 feet

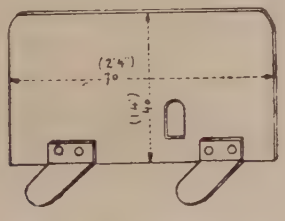


Fig. 20.—Parapet shield.

4 inches by 1 foot 4 inches and .43 to .47 inch thick; weighs 66 pounds, and will resist an armor-piercing bullet at all distances. It has a rectangular loophole 2 by 3½ inches. When these shields are assembled on the parapet, they should be placed from 1 to 2 feet apart (Fig. 21), one in front of the other, and the loopholes connected with wooden boxes covered with sand-bags or earth.

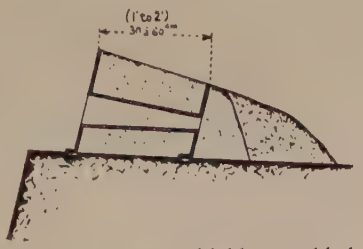


Fig. 21.—Parapet shield assembled.

c. Shields of steel, or wood and sand, or gravel (Fig. 22) can be made of a thickness to resist bullets (see Lecture I, Part IV). Loopholes or notches 2 by 3½ inches should be made on the fire crest, at intervals of a yard.

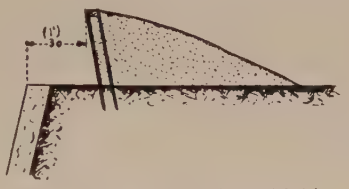


Fig. 22.—Combination shield.

An individual shield of steel and sand, 2 feet by 1 foot 4 inches, can be made with steel sheets .12 inch thick. They are bound with angle iron, which is also used to form stakes (Fig. 23). Two sheets are fastened 2 inches apart

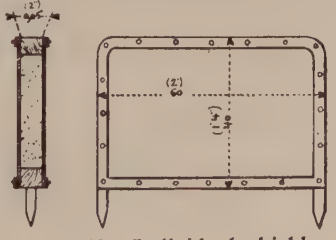


Fig. 23.—Individual shield.

with wooden strips between them, and the space filled with sand. They are bullet proof at a distance of 10 yards.

14. *General Remarks on Head Cover.*

a. It should be concealed by using grass, brush, canvas, empty sand-bags, etc.

b. The sky as a background should be avoided by raising the parados or placing a canvas curtain behind the rifleman's head and closing the opening

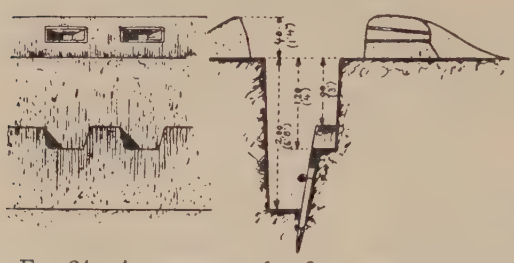


Fig. 24.—Arrangement for fire over parapet.

with a cover which can be removed when the loophole is in use.

c. In addition to its visibility, head cover has the disadvantage that it causes a pause in the fire of the defender when the attack reaches the most deadly zone of fire, because the defenders have to withdraw their rifles to prepare for bayonet fighting. It is therefore necessary to arrange for fire over the parapet. For this purpose banquettes can be constructed of sod, stone, logs or scaffolding between the loopholes (Fig. 24).

d. In some sectors the loopholes have their axes inclined to the normal.

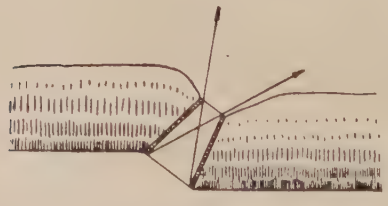


Fig. 25.—Loophole placed obliquely.

e. Every loophole intended for observation should be placed obliquely in the parapet in order to be protected against shots from the front (Fig. 25).

f. In some sectors loopholes should not be used at all.

15. *Shelter under the Parapet.*—These shelters for rest and protection against artillery fire can be rapidly and easily constructed (Fig. 26).

They must:

a. Not interrupt the line of fire.

b. Be capable of execution after the trench is finished.

c. Permit a rapid sortie.

They should be about 3 feet 4 inches wide, 5 feet high, and 6 feet 8 inches long; and will shelter from 6 to 8 men. The overhead covering should be at least 3 feet 4 inches plus the height of the parapet. In earth they should be lined. Wooden steps should replace the

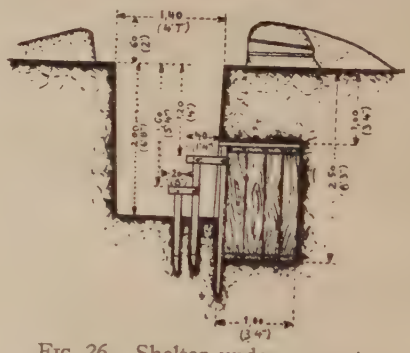


Fig. 26.—Shelter under parapet.

firing banquette, which must be removed in excavating the shelter.

Protection for the Personnel in the Immediate Vicinity of the Firing Trench

16. During a heavy bombardment which renders the trenches untenable, the personnel must be sheltered so that it will be available at the moment of assault. For this purpose shelters should be constructed with logs, earth, steel rails, concrete, and by sinking them from 25 to 40 feet under solid ground.

To limit the effects of hits, only small shelters should be used. Their maximum capacity should be from one to three squads. In the first line there must be a number of shelters so that the men who must be kept there under the most violent fire will be completely sheltered. In the rear lines and in the communicating trenches it is necessary to have numerous strong shelters for the large garrison that must be stationed there.

These shelters should be constructed on branches from the fire trench or from a communicating trench, at a distance of 10 to 12 yards from the fire trench.

17. *Cave Shelters under the Parapet.* —The advantage of these is due to the fact that they can be located close to the fire trench (Figs. 27, 28 and 29). The protection can be increased by placing a layer of steel rails on the surface of the ground to cause projectiles to burst. Two entrances should be provided, as they are liable to be obstructed by caving in. The entrances should not be placed on opposite side of a traverse, as a hit on it might obstruct both entrances. Observation from them may be pro-

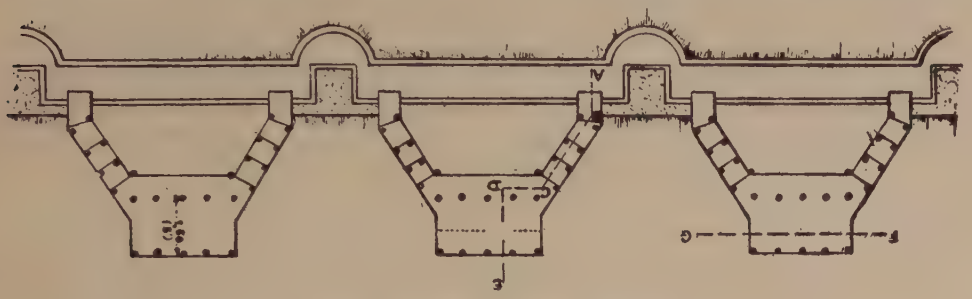


Fig. 27.—Plan of cave shelters.

Fig. 28.—Section *F-G*.

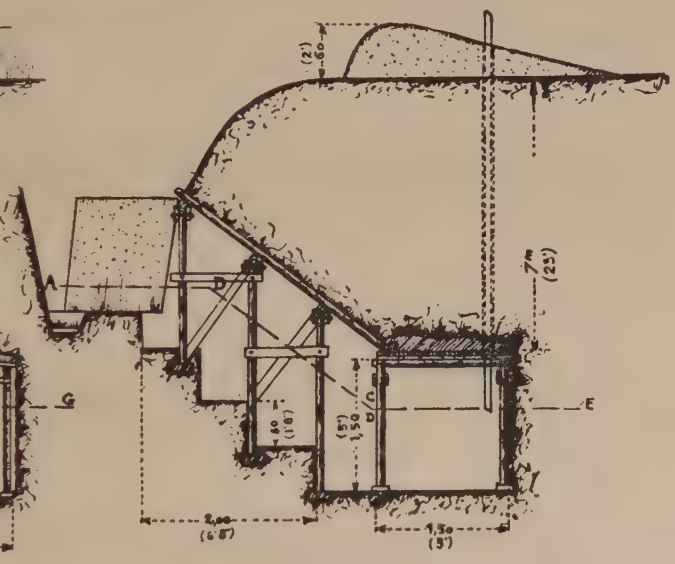


Fig. 29.—Section *A-B-C-D*.

vided by boring a hole with an earth auger to the surface of the ground, in which a periscope can be used. Ventilation is obtained in the same way. As the shelters are liable to cave in, especially at the entrance (picks and shovels should be stored in them and arrangements made for their ventilation.

18. *Shelters in Rear of the Fire Trench.*—These must be situated so that the personnel sheltered in them can man the firing crest in the minimum of time. They are on branches from the communicating trenches, immediately in rear of the fire trench, or on special trenches constructed for the shelters (Figs. 30 and 36).

Fig. 30.—Plan of shelters on the communicating trench immediately in rear of the firing trench.

a. On the communicating trench immediately in rear of the firing trench.—

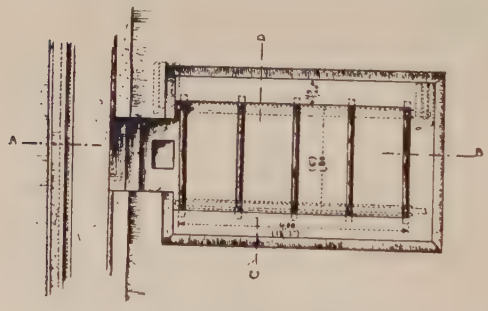


Fig. 31.—Plan of a shelter.

This trench is usually from 10 to 12 yards in rear of the firing trench and is called the circulating trench. The dimensions of the shelter, the height of the ceiling, and the arrangement of the woodwork are shown in Figs. 31 to 35 By reducing the height of the ceiling, the height of the earth thrown out on

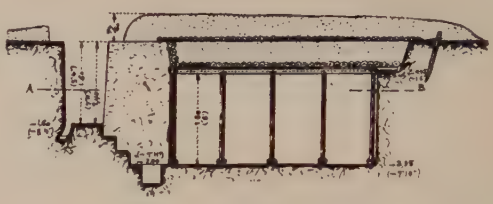


Fig. 32.—Section *A-B.*

each side of the communicating trench is diminished. The normal height of the ceiling is 6 feet; as the height of the earth thrown out must not exceed 2 feet to 2 feet 4 inches and as the depth of the communicating trench is from 5 feet 4 inches to 6 feet 8 inches, the level of the floor of the shelter will be at 7 feet 10 inches. Drainage should be provided

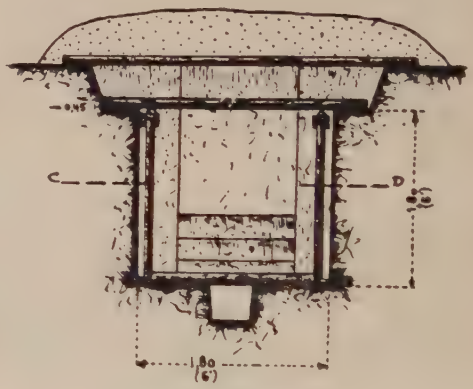


Fig. 33.—Section *C-D.*

for by constructing a drainage pit. One, or better, two entrances should be constructed from the communicating trench, and the shelters should be connected if possible. The ceiling beams should be given as much bearing as possible on the side towards the enemy, and on each side about a yard. To protect the ceiling against the effects of blast, the logs should be bound together with cross pieces, held together with wire.

which should be fastened to stakes firmly driven into the ground.

FIG. 34.—Details of construction.

The posts and caps should be connected with iron straps and bolts as shown in Fig. 34.

A more rapid but weaker method of construction is shown in Fig. 35. A

FIG. 25.—Rapid construction.

good method of resisting lateral pressure is very important.

The walls of the shelter should be revetted by the methods described in the second lecture.

for the shelters.—In certain sectors, deep shelters are arranged on both sides of a special communicating trench constructed for that purpose (Fig. 36).

This communicating trench is situated between the fire trench and the circulating trench. Their construction is similar to that of shelters under the parapet of the firing trench. They possess certain advantages for the proper supervision and assembling of the per-

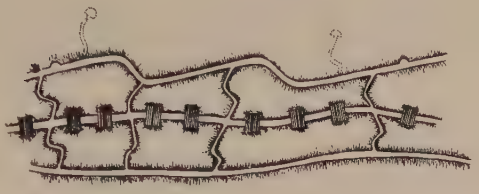


FIG. 36.—Plan of shelters constructed on a special communicating trench.

sonnel sheltered. The trench is completely covered where the shelters are constructed, and the covering is made up of successive layers of logs and earth (Fig. 37).

c. Cave shelters.—Cave shelters are constructed by the methods used in military mining. They are placed from 25 to 30 feet under solid ground, and are used for the first lines and for strong points. They should be supplied

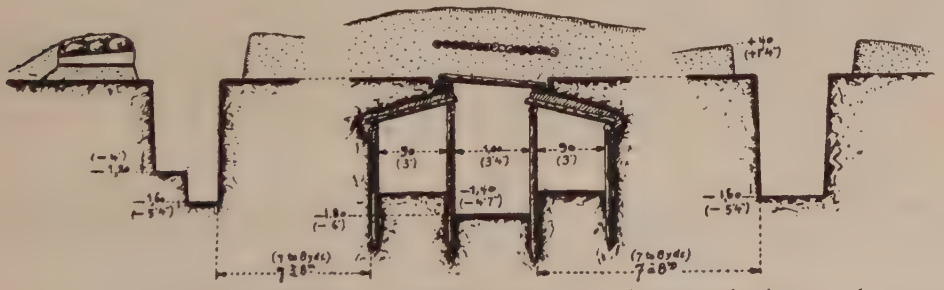


FIG. 37.—Details of shelters constructed on a special communicating trench.

For ventilation, heating, drainage, and protection again asphyxiating gas and caving in of the walls, see paragraph 21.

b. On special trenches constructed with material, ammunition and rations for several days. They are also used to shelter the command posts (par. 52) of all units. The dimensions vary ac-

cording to the garrison and use (Figs. 38–40).

Their height should be at least 6 feet 8 inches, width 10 feet, length variable, but their capacity should under no cir-

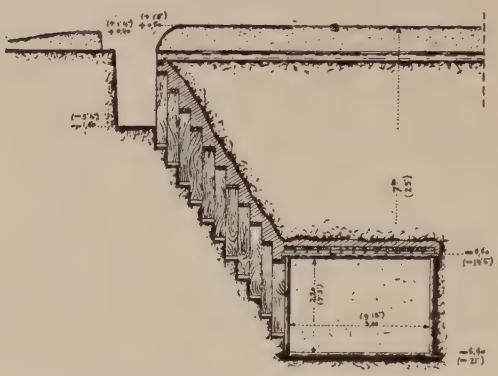


FIG. 38.—Cross-section of a cove shelter.

cumstances exceed that for three squads. The men sheltered should be able to get complete rest. Two tiers of cots or hammocks should be arranged against the walls. There should be two entrances, covered in the communicating trench by rifle or machine-gun fire from a traverse blockhouse (par. 21).

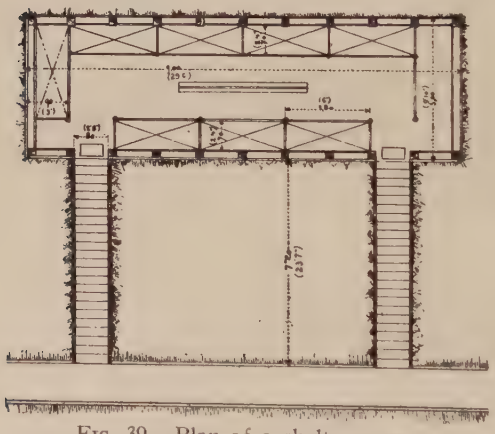


FIG. 39.—Plan of a shelter cove.

The framework and sheathing of the shelters and the galleries for entrance are constructed in accordance with the methods of military mining described in the sixth lecture.

The shelter shown in Figs. 39 and 40 is intended for a garrison of 25 men. Of these 2 would be on watch and 6 on picket duty, leaving 17 men off duty. For these there are 16 cots 6 feet by 2 feet 4 inches, arranged in tiers as shown, and a space at the right for the commander. Hammocks may be used instead of cots; they leave more space and are more comfortable.

By reducing the size of the shelter to a length of 20 feet, width 6 to 8 feet, height 6 to 8 feet, 18 men can be sheltered, 8 lying down and 10 standing.

At the upper end of the entrance gal-

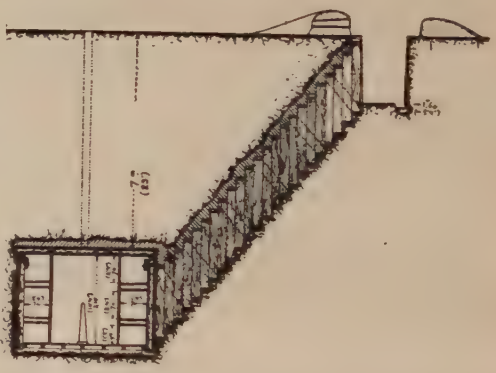


FIG. 40.—Cross-section of a cove shelter and entrance gallery.

lery there should be a niche, with a loophole for a man on watch.

PROTECTION OF THE PERSONNEL IN REAR OF THE FIRST LINES

19. *Shelters for the Reserves* intended for counter attacks, rest shelters in the zones in rear exposed to the bombardment of heavy artillery, are organized in accordance with the preceding principles. However, it is possible to utilize more fully the natural features of the terrain such as steep slopes, sunken roads, quarries, etc.; cellars of houses, and the concealment and protection of woods and forests. The con-

struction can be made stronger as there are more time, more materials and workmen available, and a relative security due to invisibility.

Fig. 41.—Shelter constructed on a steep slope.

a. Shelters utilizing natural features of the terrain (Figs. 41–45).

b. Shelters utilizing the cellars of houses.—The cellars should be connected by underground passages. The arches on the first floor should be covered with a thick layer of sand-bags, and a floor constructed to cause projectiles to burst. Ventilation should be carefully arranged and protected. Numerous exits must be provided for lateral communication and to the rear. All unnecessary openings should be strongly closed to prevent the entrance of projectiles.

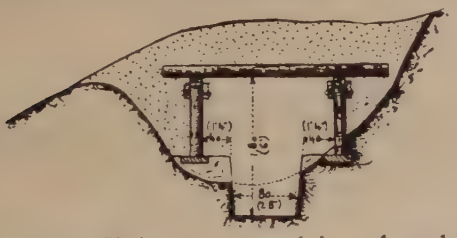


Fig. 42.—Shelter constructed in a deep depression of the ground.

Fig. 43.—Shelter constructed in a sunken road, utilizing a pile of rock.

Fig. 44.—Shelter in a quarry.

c. Shelters in woods (Figs. 46 and 47).—The height of these shelters and the quantity of material required make this construction possible only in woods. Alternate layers of logs and earth for the walls and roof afford protection from fire. The dimensions are variable, but they should provide cots or ham-

Fig. 45.—Shelter constructed in a sunken road, utilizing a line of trees.

mocks for 25 to 30 men. The cots are 6 feet by 2 feet 4 inches, constructed with a frame of wood covered with wire netting.

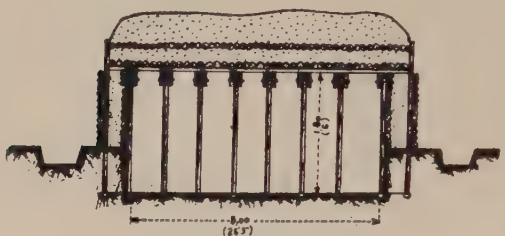


FIG. 46.—Longitudinal section of a shelter in woods.

20. *Methods of Strengthening Shelters.*—When a position is occupied for considerable time, the shelters may be strengthened by a proper combination of wood, broken stone, steel and concrete. A covering of 1 foot 8 inches of concrete affords protection against direct hits of the 105 mm. (4.13 inch) field howitzer; of 3 feet 4 inches, against those of the 130 mm. (5.12 inch) and 150 mm. (5.9 inch) mortars; of 6 feet 8 inches, against the 210 mm. (8.27 inch) mortar. By reinforcing the concrete with steel bars, steel rails, and wire mesh, the resistance is greatly increased. Concrete should be poured over a layer of steel rails or logs for the roof, and the walls and floor should be similarly concreted.

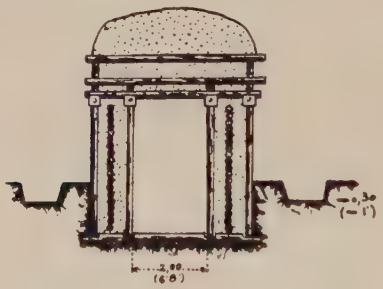


FIG. 47.—Cross-section of a shelter in woods.

a. Roof of earth and steel rails with an intermediate layer of stone (Fig. 48).—The rails are placed on heavy sills such as cross ties (Fig. 51), side by side and firmly fastened together with wire. A second layer is added if practicable, or a layer of earth from 1 foot to 2 feet thick, then a layer of broken stone 2 feet thick, and on top a second layer of earth from 2 to 3 feet thick. The total thickness of the cover should be from 5 to 7 feet.

b. Roof of timber, earth and an intermediate layer of broken stone (Fig. 49).—This roof consists of two or three layers of timber. Between these are placed layers of earth, 12 inches thick, to deaden shock. An intermediate layer of broken stone, with concrete poured over it if possible, greatly increases the protection. It has little height above the ground, affords great protection, and can replace cave shelters.

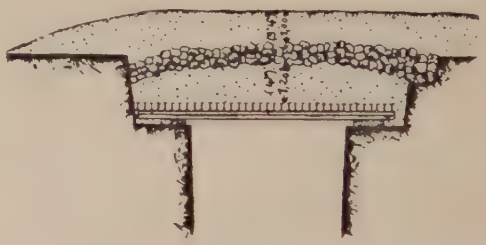


FIG. 48.—Roof of earth, broken stone and steel rails.

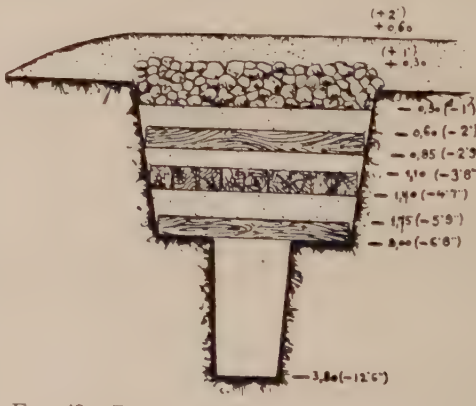


FIG. 49.—Roof of earth, timber and broken stone.

c. Roof of earth, broken stone, concrete and steel rails (Fig. 50).—This kind of shelter is specially suitable for the protection of assembly places near the first lines. The trench is broken by traverses 8 feet 4 inches thick and 5

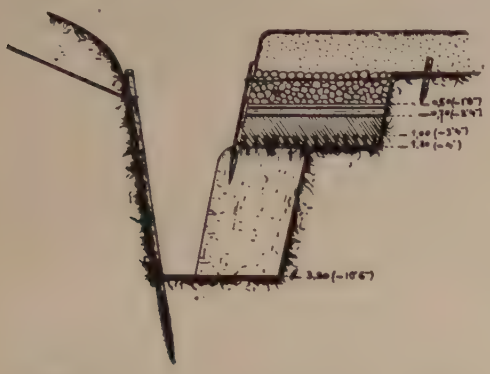


Fig. 50.—Roof of earth, broken stone, concrete and steel rails.

yards apart. The rails should be at least 8 yards long for the longitudinal layer and about 3 yards for the transverse layer. They will then have bearing of 4½ feet on the traverse on each side. It is important to provide a proper bearing for each layer of rails, not only on the traverses but also on the front side of the trench.

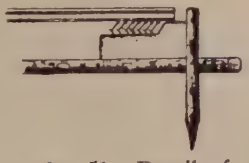


Fig. 51.—Detail of arrangement of steel rails.

d. Shelter of corrugated iron.—Corrugated iron is neither proof against bullets nor the fragments of artillery projectiles or those of trench weapons, but it can be used to support the thickness of the earth which gives the necessary protection. Its great advantage is that, with it, the construction of the shelter, once the excavation is finished, is rapid and easy.

21. *General Remarks on Shelters.*

a. Security.—A shelter is only valuable when it affords protection to the garrison and is so arranged that they can leave it promptly in case of an attack. Its roof and walls should be thick enough to resist penetration of the projectiles fired against it (see the second lecture, where the required thickness of various materials is given).

In order that the garrison may leave it promptly in case of attack, there must be a look-out placed to one side of the shelter in a protected niche, sunk into the parapet, concealed and furnished with means to communicate with the shelter to give the alarm; if the means of communication is interrupted, the look-out must leave his post.

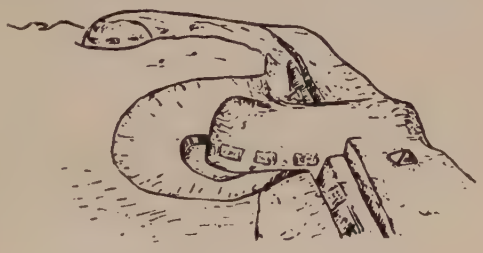


Fig. 52.—Traverse blockhouse.

To give the garrison time to get out, even if the enemy be actually in the trench, it is necessary to construct *traverse blockhouses* at intervals. These should cover the exit of the shelter and its vicinity (Fig. 52). The firing position communicates with a shelter for several men with rifles or automatic rifles, who can enfilade the trench. The blockhouse is constructed of rails and concrete. Besides the positions for the look-outs, a certain number of shelters should be provided with means for using long periscopes from the inside

(Fig. 40). When an attack is expected the officers and noncommissioned officers remain in the shelter with their men.

b. Arrangements to cause projectiles to burst.—As has already been explained in paragraph 5 for the parapets, and in paragraph 17 for cave shelters under the parapet, the protection of the personnel can be greatly increased by causing projectiles to burst in front of the shelters by using layers of logs, or above the shelters by using steel rails in the roofs.

c. Protection from rain.—Rain-water filters through all soils, especially through loose earth that has been placed over the shelters. Protection is secured by placing, on one layer of logs, roofing paper, corrugated iron, tin or zinc, linoleum, canvas, tiles, etc.

Fig. 52a.—Ventilation arrangement.

d. Drainage.—It is necessary to provide drainage for water which runs into the shelter through the entrance or seeps through the walls. A pit should be dug near the entrance and the floor of the shelter should be sloped towards it; the pit must be emptied when necessary.

e. Ventilation and protection against asphyxiating gas.—Ventilation is secured by boring vertical or inclined holes with an earth auger through the roof. These can also be used for periscopes (Figs. 40 and 52). Against asphyxiating gas it is necessary to hermetically seal the shelter as soon as the alarm is given. For this purpose two curtains of canvas or blankets are placed at the entrance, a certain distance apart. There must always be a barrel of a solution of hyposulphate of soda in the shelter, which should be sprayed into the air.

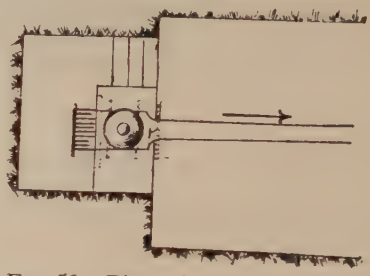


Fig. 53.—Plan of heating system.

f. Protection against caving in of the walls.—The walls should be revetted by the methods described in the second lecture. Picks and shovels should be stored in the shelter so that the garrison can dig their way out; an earth auger should also be available so that ventilation can be secured and a hole made rapidly for food and water to be passed into the shelter. There should also be stored in the shelter, food, ammunition, grenades and rockets to warn the lines in rear.

g. Heating is provided by cast iron stoves, or, if stoves are not available, by braziers placed in niches below the level of the floor of the shelter and at

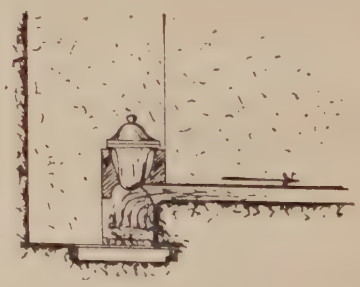


Fig. 54.—Cross-section of heating system.

one end of it (Figs. 53 and 54). If the shelter is long, the flue is carried through its length so as to get the maximum of heat. This pipe is made by a

FIG. 55.—Flue made of tiles.

trench 3 by 5 inches covered with tiles (Fig. 55). The tiles should be arranged as indicated in the figure, with reference to the direction of the smoke, and the joints should be calked with

FIG. 56.—Flue of pipes.

FIG. 57.—Flue of tin or iron sheets.

clay; or by using stove pipe, drain pipe, or gas pipe (Fig. 56); or with sheets of tin or iron to cover a trench (Fig. 57). The pipes are banked with tamped earth to keep them in place.

PART III

CONSTRUCTION OF SHELTERED COMMUNICATIONS

22. *General Principles.*—It is necessary to communicate with ease, rapidity and security:

a. Toward the front with the advanced elements of observation, such as small posts, listening posts, etc.

b. Laterally with the adjoining elements of the firing line.

c. Toward the rear with the food and ammunition depots, the command posts, and the reserves.

A distinction can be made, according to the length of occupation of the position, between improvised communications and sunken communications. The first belong to light field fortifications; they are arranged rapidly with the main object of screening the movements of troops from the view of the enemy, as there is not time enough to shelter them from fire. In woods this is easily secured, but it is necessary to place signboards for use during the day, and lanterns at night, which will indicate the routes to be followed.

Lateral communications.—A communicating trench with a firing crest, protected with barbed-wire entanglements, should connect the centers of resistance, thus forming a continuous line of trenches and preventing the enemy penetrating between the strong points.

Communications to the front and rear.—These connect up the successive lines of trenches. They should be protected on both sides by barbed-wire entanglements. Some are arranged for firing and are provided with a firing banquette and elbow support.

23. *Ordinary Communicating Trenches* (Fig. 58).—The relief must not be less than 6 feet; it is usually 6 feet 8 inches. They should be concealed as much as possible by making the parapets not more than 1 foot 4 inches to 2 feet high, and giving them a flat slope and rounded crest. The earth should be spread out and the exterior slope of the parapets made uniform so that grenades that fall on it will roll away from the trench. There should be a berm of about a foot on both sides to:

a. Prevent the earth from falling into the trench and making it muddy.

b. To form a small platform for tools, packs and rifles, and to give more space for two columns to pass each other.

c. To permit infantrymen with packs to leap over the trench.

When water or rock is near the surface it is necessary to make the parapets

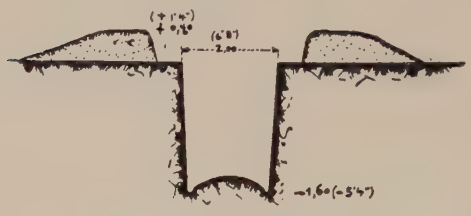


Fig. 58.—Communicating trench.

higher, and in some places no trench can be dug and parapets must be made of gabions, sand-bags, etc.

The width varies with traffic through it, but it should be at least 3 feet 8

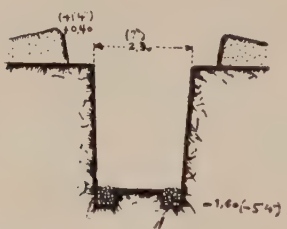


Fig. 58a.—Communicating trench.

inches at the top and 3 feet at the bottom. The bottom of the trench should be constructed and maintained slightly convex for drainage, or a ditch, filled

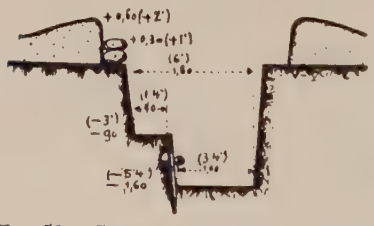


Fig. 59.—Communicating trench with single fire crest.

with small stones, should be constructed on both sides. To allow troops to move in column of twos the width should be increased to at least 5 feet; for the movement of vehicles such as artillery and supply wagons it should be 8 feet 4 inches. In this case the relief should be increased to from 9 to 10 feet. The trench should be widened by 2 feet 8 inches to 3 feet 4 inches at certain distances to permit men to pass each other.

24. *Communicating Trenches Arranged for Firing* (Figs. 59 and 60).—When it is necessary to arrange for firing on one or both sides, as the parapet

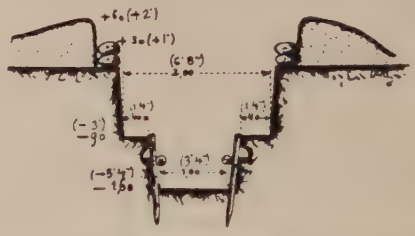


Fig. 60.—Communicating trench with double fire crest.

already has a height of at least 1 foot 4 inches, it is usually raised to 2 feet; and as the relief for firing must not exceed 5 feet a banquette at least 3 feet below the surface of the ground must be con-

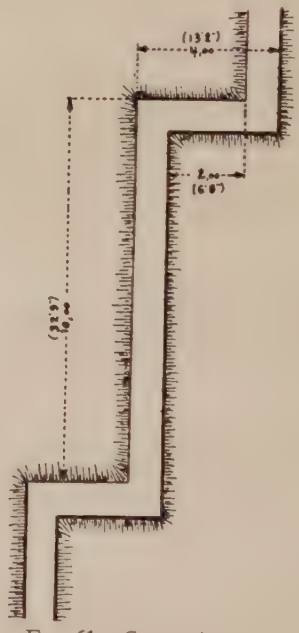


Fig. 61.—Stepped trace.

structed. If it is undesirable to widen the trench for this purpose, wooden benches may be stored in passing places so that they can be set in place rapidly when it is desired to open fire.

25. *Trace.*—When the construction of communicating trenches is hurried and they are not traced with stakes and compass, they are usually given a trace with gentle curves, which do not protect from enfilade fire and cannot be defended by flank fire. The only traces that should be used are: (*a*) the stepped (Fig. 61); (*b*) the traversed (Figs. 62 and 63), both of which are easy to con-

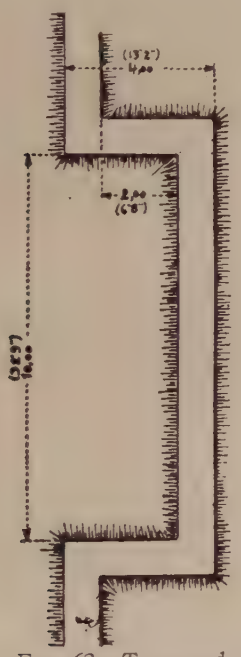


Fig. 62.—Traversed trace.

struct and to defend; and (*c*) the zigzag (Fig. 64), which gives better defilade and provides numerous flanking elements.

The stepped and traversed traces are preferable for approaches that are used for bringing up men and supplies, as they are shorter; the zigzag trace is better for the evacuation of wounded, as the litters can be carried around the turns easier. The angle between two branches should not be less than 30 degrees in order not to make the length of the trench too great. The longer

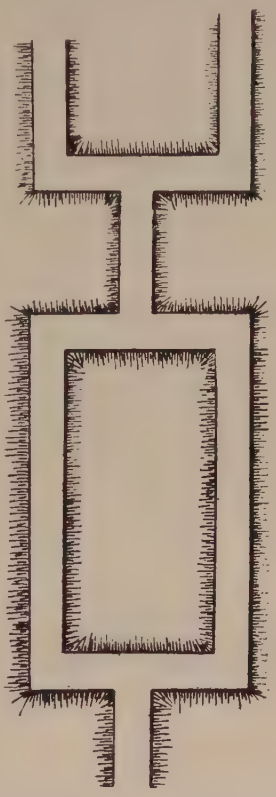


Fig. 63.—Island traverse.

branches of the stepped and traversed trenches should not have a length greater than 10 yards in order to defilade it; the short branches should be at least 4 yards long, so as to project at least 2 yards beyond the longer branches.

The zigzag trace is executed in the following manner:

a. The direction of the approach being determined by a line *NM*, give to the first branch *ab* a length of 4 to 6 yards, and an inclination of 30 to 45 degrees, and place the middle of the cord

representing the exterior edge of the trench on the line MN at a point x^1.

b. Then lay off on MN the distances x^1x^2, x^2x^3, etc., equal to double the distance of x^1 from the front edge of AD. Place stakes to mark these points.

c. Two men placed at the ends of the cord ab alternately stretch the cord from b to c and the man on the right places the stake c when the cord bc, stretched, is in contact with x^2.

In the same way, the man on the left places the stake d where the cord held at c, and stretched, passes the stake x^3.

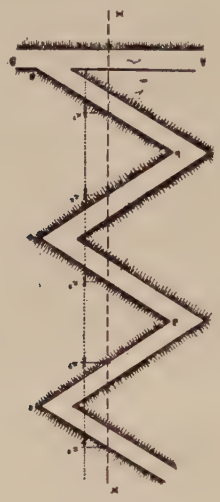


FIG.—Zigzag trace.

d. Then join the points a, b, c, d and outline at 3 feet 4 inches or 3 feet 8 inches the trace of the interior edge of the trench. Round off the angles.

Continuity of the trace (Fig. 65).—A part of a parallel should never be used as part of an approach, as $DABC$. Besides causing confusion it renders passage through the approach difficult when the parallel is occupied by troops. It should be remembered that the rate of travel through an approach is that at its most difficult point, such as at a tunnel under a road, a bridge, water hole, etc. A connecting trench, as AC, should be dug.

Trace at the angles.—Whatever form of trace is used, the passage around the

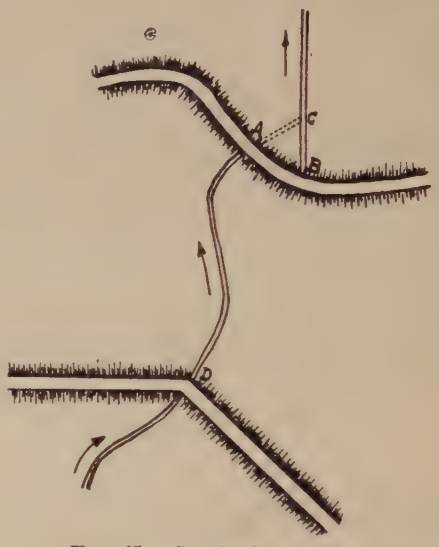


FIG. 65.—Continuity of trace.

angles in the trace should be easy and permit the passage of litters for wounded, especially in the approaches for the evacuation of the wounded. This result is obtained in the following manner:

FIG. 66.—Trace at obtuse angle.

a. For obtuse angles, round off the reentrant angle and blunt the salient angle (Fig. 66).

b. For right and acute angles, widen or round off the angles (Figs. 67 and 68).

26. *Execution.*—When sheltered from the enemy's fire, or at a distance, or at

night, the approaches are constructed in a manner similar to the construction of trenches as explained in the second

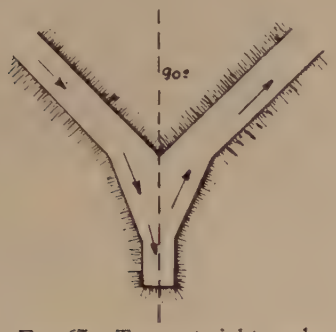


Fig. 67.—Trace at right angle.

lecture. Work at night is specially recommended.

Under fire of the enemy, when it is necessary to join the first lines with elements of a captured trench, with a

Fig. 68.—Trace at acute angle.

listening post, or with a mine crater, the methods of sapping or the methods of mining described in the Engineer Field Manual are used according to the circumstances. These methods are described in the sixth lecture.

27. *Tracing.*—The construction of an approach should be preceded by carefully staking it out with careful measurements. The measurements are necessary in order to secure economy of time and to permit the clear formulation of orders for the conduct and completion of the work.

28. *Signposts.*—At all branches there should be placed in each branch two solid signposts, planted firmly in the berm beyond reach of accidental blows and in a niche where a lantern can be placed, and placed so that they will attract the attention of men passing in either direction. The approaches should be named, and these names should be kept all the way through, as they constitute important reference lines in maps of the defenses. Besides signposts, the principal approaches are distinguished from the minor ones by making them from 1 foot to 1 foot 4 inches deeper at all forks or crossings.

29. *Stairs, Storage Places, Footbridges, Niches.* — Frequent storage places and steps for leaving the approaches should be provided. Steps are also necessary at the crossings of other approaches or parallels; these are used at night, with a foot-bridge over the principal approach. By providing two stairways, the rate of march through the approach will not be decreased much. Foot-bridges may be constructed over all the trenches which cross an important approach, and these, with a path parallel to the approach, may be used at night in order to supplement the approach and lessen the time required to reach the front.

There is a tendency to dig, by individual initiative, shelters and niches in the approaches; this tendency should be repressed. Everything tending to cause a halt, hence loss of speed, must be prohibited. An approach should be kept absolutely clear, and nothing should open into it except other approaches.

30. *Bridges over the Approaches.*—These should be constructed in proper places, with a layer of logs.

31. *Covered Approaches.*—On particularly exposed points, the approaches should be covered with splinter-proof

roofs, constructed according to the principles of the roofs of shelters, as previously described.

32. *Dispositions for Defense.*—The lateral communicating trenches and the approaches can in certain cases be arranged like firing trenches and can be protected by barbed-wire entanglements. They assist thus in the defense of the front and in the flanking dispositions for the intervals between the supporting points.

Moreover, the approaches should be organized so that they can be defended by rifle, grenade and machine-gun fire over every foot, and they should be arranged so as to trap the enemy if he should get into them.

The dispositions for defense by rifle and machine-gun fire can be organized at a distance from or at one end of a straight line of approach. If the rifle or machine gun is placed at a distance to facilitate the fire, sections 1 yard in length will be removed from the parapet of the approach. Sometimes it will be necessary to cut away part of the side of the approach. At the end of a straight line of approach the arrangement will comprise a small firing trench, a yard long, provided with one or two loopholes and with a position for a grenade thrower immediately behind the firing trench (Figs. 69 and 70).

FIG. 69.—Cross-section of an arrangement for the defense of an approach.

The traps will consist:

a. In making island traverses or blind approaches, and of placing false walls on the opening of one of the two trenches around the traverse. The enemy having passed the island traverse, or opening of the blind approach, will be at the mercy of the defenders hidden in the part concealed from view.

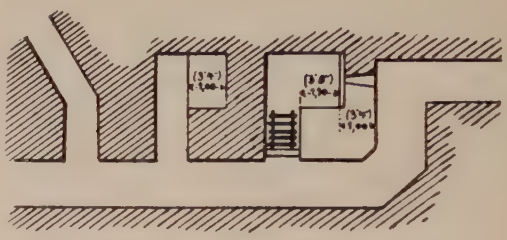


FIG. 70.—Plan of arrangement for the defense of an approach.

b. In closing with a false wall the opening of a shelter where the defenders can act in the same way.

c. In making, outside the approach and in its immediate vicinity, holes where defenders can be hidden who can isolate advanced hostile groups.

d. In making false approaches which rise gradually to the ground level. When the heads of the enemy appear, riflemen posted in a proper position can shoot them down.

33. *Maintenance.*—The trenches and approaches, after prolonged use, deteriorate, not only from the fire of the enemy but also from the effects of the weather. They must constantly be repaired. Walls which break down must be revetted. Firing banquettes must be constantly repaired with planks, fascines, etc. Damaged parapets must be repaired. Berms must be kept at proper width. Drainage pits must be watched carefully and kept cleaned out. It requires constant work to keep the trenches clean and sanitary. Any commander who tolerates lack of work or poor work under any pretext is wanting in the first duty of a commanding officer.

When parts of trenches or approaches are captured, steps must be taken immediately to clear them of insects which swarm there and transmit disease germs, particularly typhus. Straw should be burned in the trenches and shelters, and all wood should be whitewashed.

Part IV

Construction of Shelters for Observation, Illumination and Communication

34. *Observation.* — The observation of the enemy is of first importance in position warfare. It should give complete knowledge of all the elements of the hostile line and prompt information of any movement of the enemy. It is effected by observation from the ground and observation by aircraft.

Observation from the ground is divided into three echelons:

a. Observation in front of the first line from small posts and listening posts.

b. Observation on the first line by sentinels and lookouts.

c. Observation in rear of the first line by artillery observers, sentinels, and lookouts of the shelters.

It is effected by the infantry and artillery.

35. *Observation in Front of the First Line.*—The small posts or listening posts of from 1 to 8 men are placed in rifleman's pits, shot holes, organized shell craters or in short semicircular elements of trench, connected with the first line by sap or low mine gallery. Their protection is assured by their invisibility. The retreat of the observers is protected:

a. By a system of branch galleries whose entrance into the main gallery can be rapidly closed.

b. By a barbed-wire protection placed over the sap.

The look-outs in small posts are placed in very short trenches, which are provided with loopholes. Protection at short range against grenades is secured by a network of wire.

36. *Observation on the First Line.*—This is effected by look-out posts organized preferably at the salients where the view is more extended. These posts give a view over the enemy's first line. They are provided with periscopes, with range finders, and large scale maps.

a. Simple hole in the parapet.—It will often be sufficient to pierce a circular opening in the parapet with a stick or to place a pipe in it.

b. Armored shelters and sentinel boxes.—These are provided by the engineer park and can be put into position without further preparation. The shelters have four sides and shelter

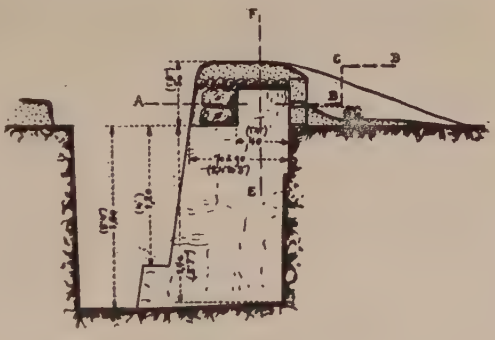


Fig. 71.—Observer's post of sheet steel and sand-bags.

only the head of the observer. The sentry boxes are cylinders large enough to shelter the entire body of the look-out. They are made of special steel, .47 inch thick, of reinforced concrete, or of double steel walls .12 inch thick with a

space of 4 inches filled with gravel or well-packed earth.

c. Shelter of sheet steel and sand-bags (Figs. 71, 72, and 72*a*).—The shelter is formed with a caisson of sheet steel. Two box-like receptacles on the front face are filled with gravel. The upper part is strengthened by a layer of logs and a covering of earth. The lateral part in rear is covered with sand bags. The front face is bullet-proof; the side walls protect from oblique fire and the roof from the burst of projectiles. A similar shelter can be improvised from materials available if spe-

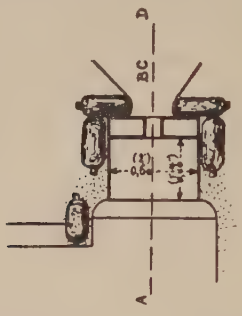


Fig. 72.—Plan through *A-B*.

cially prepared steel sheets are not on hand.

d. Shelter of steel rails and sand-bags (Fig. 73).—An easy type to improvise is shown in Fig. 73. Two steel rails, 2

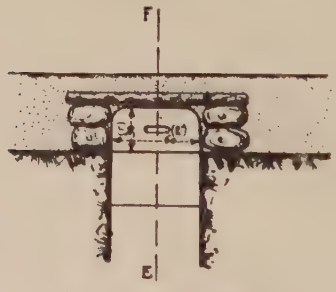


Fig. 72a.—Plan through *E-F*.

feet 8 inches in length, are placed horizontally a few inches apart, parallel to the trench. Upon these is constructed a roof to protect against the burst of projectiles. A frame protected by sand-bags covers the rear.

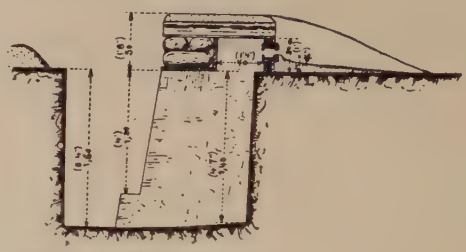


Fig. 73.—Observer's post of rails and sandbags.

e. Concealment of look-out posts.—It is necessary to conceal these posts by all possible means. Observation is carried out under good conditions only when it is done without the knowledge of the enemy. The posts should preferably be constructed on the right of a traverse, and in an excavation in front of the trench wall (Fig. 74).

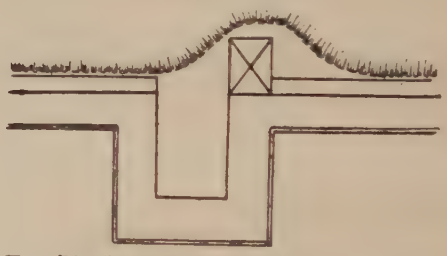


Fig. 74.—Location of an observer's post.

37. *Observation in Rear of the First Line.*—The observation posts, even of the infantry, are not necessarily in the first line trench or in the listening posts. Often, in the rear, points will be found which will give an excellent view and will not attract the enemy's attention. The term "observatory" is often employed for this kind of observation post.

The observatory generally has a more extended view than the look-out's post; it is protected and has means of communication such as telephone, helio-

graph, messengers, carrier pigeons, wireless. It may belong to the infantry, the artillery, or the higher commands. The observatory may be occupied by the commander himself or by an observer who represents him. In any case the observatory is near the command post. It is only useful so long as it can resist bombardment, therefore must have a low parapet, be defiladed from view, and proof against the large projectiles. A good form consists of a steel sentry box, sunk into a mass of concrete or placed at the end of a sap. They must be provided with large periscopes. Their construction must be made with the greatest care, the excavated earth removed to some distance, the position concealed, etc. It is a good idea to make false observatories, relatively visible, at some distance from the real ones.

38. *Coordination of Observing Stations.*—The location of the look-out posts and observatories must be determined in accordance with a complete plan for each center of resistance or sector of defense. No part of the hostile front should be free from observation, and the parts of the front favorable for the attack of the enemy should be specially watched. An observatory should be located near the combat posts of the commanders of the supporting points, centers of resistance and sectors. The observatories of centers of resistance and of sectors must have extended views over the whole of the terrain.

39. *Illumination of the Battlefield.*—In position warfare it is necessary:

a. To discover and keep in touch with the movements of the enemy during the night.

b. To seek out and illuminate hostile objectives so as to fire upon them.

c. To blind the enemy.

These results are obtained with searchlights. The smaller ones, about 12-inch, are acetylene, and have a short range. The larger, about 24-inch, are electric and have a longer range. They can also be used for signaling. They are placed in shelters, similar to those for machine guns, located so as to flank the line of fire (Figs. 75 and 76).

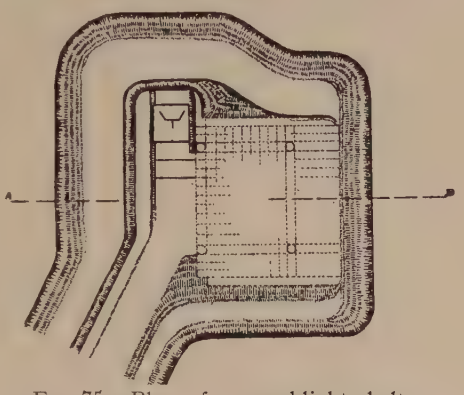


FIG. 75.—Plan of a searchlight shelter.

They can also be placed in rear of the first line on a platform with no overhead cover; but the personnel should be protected by a shelter close to the platform, from which the searchlight may be operated. The generating apparatus should be placed in rear under a strong shelter.

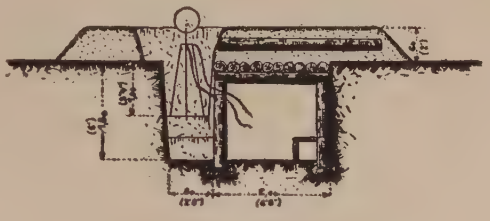


FIG. 76.—Searchlight shelter, cross-section *A-B*.

40. *Communication.*—During a bombardment communication becomes very difficult, but it must be maintained by all possible methods. This may be accomplished by:

a. Installing telephones under strong shelters.

b. Using lead covered cable, buried 6 feet deep, especially for the lines connecting the regimental, brigade, division and corps headquarters.

c. Placing rockets in all shelters and observatories where officers or noncommissioned officers are posted.

d. Preparing posts for visual signaling, safe from bombardment and defiladed from view of the enemy. These posts are constructed in shelters similar to those for searchlights and are provided with horizontal loopholes with the opening to the flank or rear.

Part V

Depots for Material, Ammunition and Arms; Emplacements and Shelters for Machine Guns and Trench Weapons

41. *Depots for Material and Ammunition.*—These consist of galleries of variable dimensions, opened in the walls of the trenches and approaches and usually lined with timber like mine casings. The entrance should be closed with a strong door. They are used to store water, rations, ammunition, grenades, pioneer tools, portable searchlights, field glasses, maps, range finders, periscopes, lighting pistols, rockets, etc. Depots for engineer material are usually installed in the angles of the approaches. Depots for water, rations, tools and sand-bags are usually established about 20 yards to the right of the company "command post" (par. 52). Depots for arms, ammunition, bombs, grenades, and rockets, about 20 yards to the left of the same post. An inventory of the material should be kept up to date at the company "command post."

42. *Principles of the Employment of Machine Guns.*

(1) The personnel and materiel should be protected from fire as much as possible.

(2) In order that they may be available at the moment of attack, it is indispensable that they survive the bombardment. Their protection must therefore be specially provided for, by employing all of the following means: (*a*) placing them under shelter; (*b*) making their emplacements invisible; (*c*) placing them in echelon.

(3) Casemates must be used only when they cannot be seen by the enemy, such as on the reverse slope, in woods, in villages, etc.

(4) The great importance of making the machine guns invisible necessitates the construction of firing emplacements outside the shelters, but close enough so that the guns can be put in action with the least possible delay.

(5) The firing emplacement may be protected by a light roof with very slight height, or it may be entirely without overhead protection. The emplacement may consist simply of a pit in the open field, situated in front or in rear of the parapet and connected with the shelter by an underground passage. The machine gun should be placed in action at the last moment; it may be simply placed on the edge of the pit without any protection, or preferably it should be covered by a light shield or a low parapet joining the natural slope of the ground with a gentle slope. The pit should be carefully hidden and will usually not be discovered by the enemy. Emplacements of this nature are frequently employed in rear of the first lines.

(6) When the trench is situated on the reserve slope, machine guns should be emplaced in concealed pits in front

of the trench and connected with it by underground passages.

(7) The requirements of invisibility make it necessary to conceal all the approaches to the firing emplacements by making them underground, and to increase the number of emplacements so that it will not be necessary to fire daily from those to be used in case of an attack.

(8) The emplacement of too many machine guns in the first line is dangerous; in order to stop an attack they should be echeloned to the rear. In favorable terrain, flank fire should be provided, to mow down the attacking lines as they push forward. Therefore the available machine guns should be distributed between the first line and the terrain in rear, with each emplacement prepared in a manner suitable to the terrain and object in view.

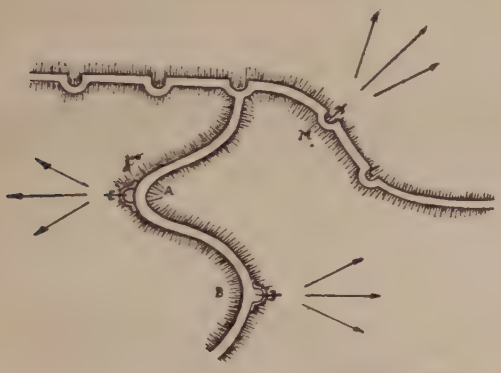


Fig. 77.—Location of machine-gun emplacements.

43. *Machine-gun Emplacements.*—An emplacement without overhead cover may consist of a simple platform constructed on the edge of the firing trench, where a flanking fire may be obtained; or on an approach where the terrain to the flank may be covered. The locations *M*, Fig. 77, on the first line, and *A* and *B*, on the approach, will give an effective flank fire in case of a hostile penetrating attack.

An emplacement with movable light head cover and low command is shown in Figs. 78, 79 and 80. The emplacement is made in front of the trench,

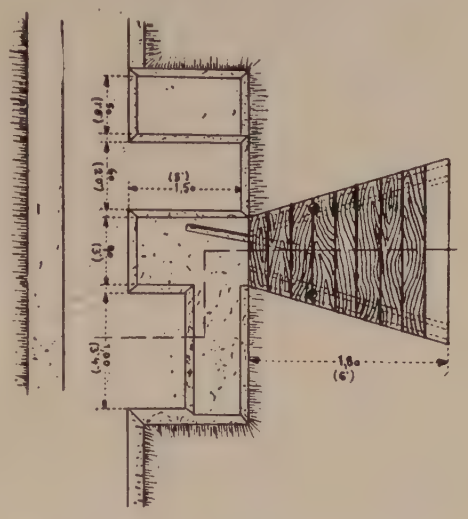


Fig. 78.—Plan of machine-gun emplacement with movable, light head cover.

with recesses and benches on each side for the personnel and ammunition. The head cover is hinged and is made of corrugated sheet iron, covered with earth, blending exactly in color and appearance with the front slope of the parapet. By raising the head cover with a lever, a loophole 3 feet by 1 foot is opened, which permits an effective fire.

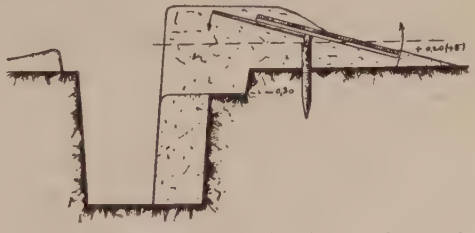


Fig. 79.—Profile showing head cover lowered.

44. *Shelters for Machine Guns.*—The bomb-proof shelters whose details of construction have been given constitute

a series of types from which choice may be made, depending upon the tactical requirements, the possibilities for defilade, and the materials available.

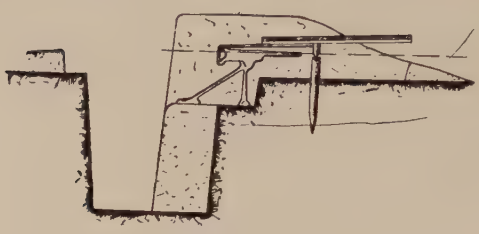


FIG. 80.—Profile showing head cover raised, machine gun ready to fire.

a. Shelter with revolving platform (Fig. 81).—The platform or support for the gun revolves on a circular base. The machine gun may be placed in action very quickly. The shelter is proof against only bullets and shell fragments. The roof is made of flagstones in two layers with corrugated iron between, supported by timber and covered with earth. The sides above the ground are closed with sand-bags and earth, and the emplacement is revetted with planks nailed to the posts.

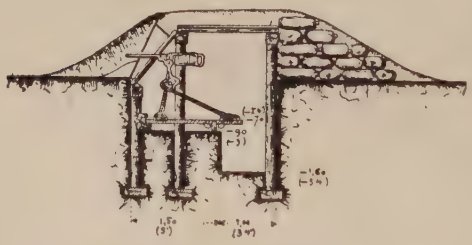


FIG. 81.—Shelter for machine gun with revolving platform.

b. Shelter of reinforced concrete steel rails (Figs. 82 and 83).—This gives much greater protection than that shown above. The roof is formed of a layer of steel rails over a layer of logs, supported by timber and firmly bound together with wire. Over the rails is a layer of earth 1 foot 4 inches thick. Protection from direct hits is secured by a shield of rails in which a loophole is arranged. The walls of the shelter should be revetted, and benches should

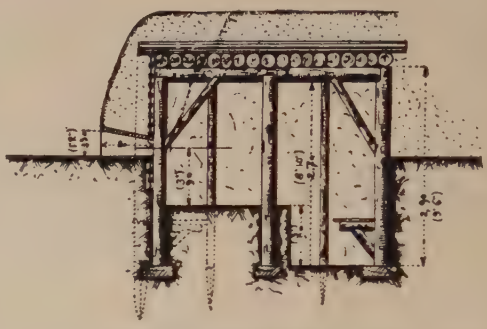


FIG. 82.—Profile of machine-gun shelter with overhead cover of steel rails.

be constructed for the personnel and ammunition. The roof should be made waterproof by covering the rails with

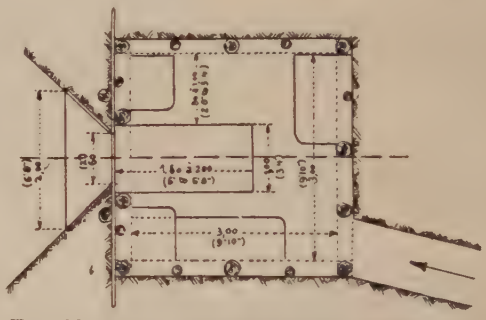


FIG. 83.—Plan of machine-gun shelter with overhead cover of steel rails.

tar paper. This shelter gives protection from shells of small caliber. It has considerable command (4 feet 8 inches)

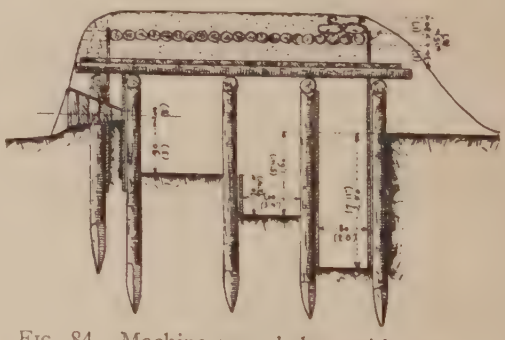


FIG. 84.—Machine-gun shelter with roof of earth and logs.

and therefore should be used only when it can be concealed.

c. Shelter with roof of earth and logs (Fig. 84).—This is similar to that described above, and has the same plan. It is proof against shells up to 6 inches. It has considerable command and

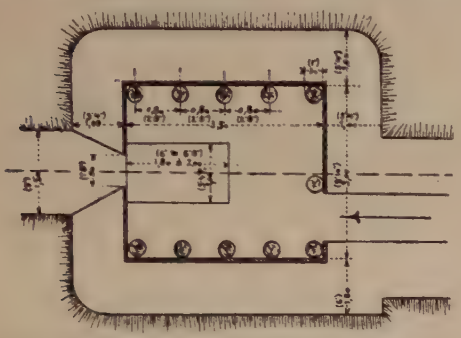


FIG. 85.—Plan of machine-gun shelter with roof of steel rails and concrete.

should therefore be used only where it can be concealed.

d. Shelter with roof of steel rails and concrete (Figs. 85 and 86).—The roof is constructed of two layers of steel rails separated by an 8-inch layer of concrete, and covered with earth and sacks of concrete, or of cement hard-

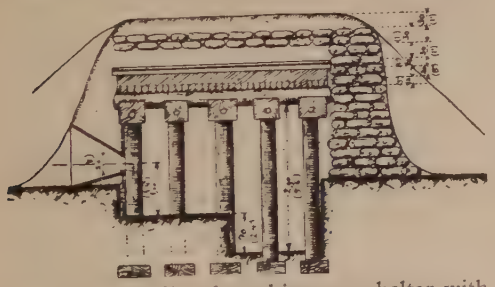


FIG. 86.—Profile of machine-gun shelter with roof of steel rails and concrete.

ened by wetting. When sacks of cement are used they should be bonded together by filling the spaces between them with loose cement moistened. This shelter is proof against the projectiles of large-caliber mortars.

e. Shelter of reinforced concrete (Figs. 87, 88 and 89).—This is used when it is necessary to construct a powerful flank defense in the first line and it is impossible to conceal it properly.

FIG. 87.—Location of reinforced concrete shelter for machine guns.

It is constructed entirely of reinforced concrete. The roof is constructed of two layers of steel rails separated by a layer of concrete and covered with con-

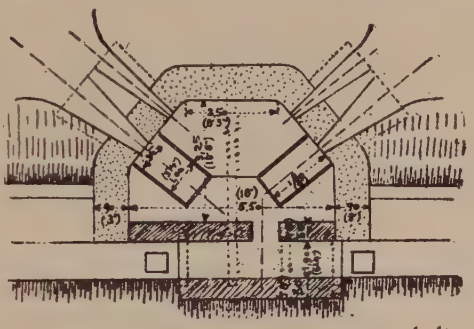


FIG. 88.—Plan of reinforced concrete shelter for machine guns.

crete reinforced with steel rods .3 to .4 inch in diameter. It will give protection from hits of the largest projectiles, and affords protection for the personnel

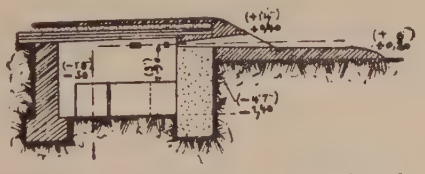


FIG. 89.—Profile of concrete shelter for machine guns.

of two machine guns. The command does not exceed 3 feet 4 inches.

45. *Emplacements for Machine Guns for Firing at Aircraft* (Figs. 90 and 91).—These emplacements should be

constructed in branches of the approaches or in rear of the front trench. Fig. 90 shows a machine gun mounted on post with a revolving block; Fig. 91, on a wheel with its axle fixed in a barrel filled with sand.

FIG. 90.—Emplacement for a machine gun mounted on a post for firing at aircraft.

46. *Emplacements and Shelters for Trench Weapons.*—In trench warfare, batteries of light mortars of the first line are generally situated between the front and the support trenches. Like machine-gun emplacements they are of

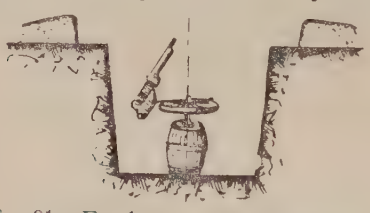


FIG. 91.—Emplacement for a machine gun mounted on a wheel.

two types, viz., with and without overhead cover. Whenever overhead cover is used, if practicable, alternative emplacements without it should be constructed nearby. The emplacements should be concealed as much as possible, and for this purpose the command should not be greater than that of the adjacent trench. The guns should be echeloned as indicated for machine guns.

47. *Emplacements for Trench Mortars, without Overhead Cover.*—Fig. 92 is a plan of an emplacement for two trench mortars. A battery of four to six mortars should be divided up into platoons of two mortars, by traverses. A lateral trench (Fig. 93) affords communication between the platoons and for the ammunition service; this trench branches off from the system of approaches. The mortars are placed on platforms 3 feet 8 inches square (Fig.

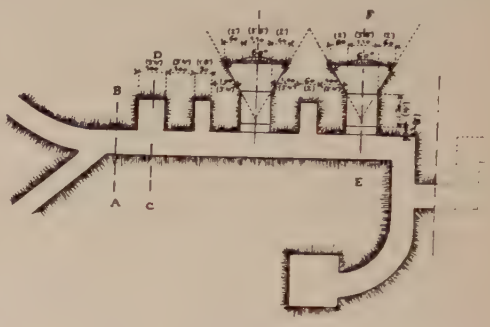


FIG. 92.—Plan of an emplacement for two trench mortars.

95), separated by traverses made of sand-bags or gabions 3 feet 4 inches thick to localize the effects of projectiles. Niches are constructed to one side of each platform to enable the gunners to fire the mortars under cover. Ammunition recesses (Fig. 94) are constructed

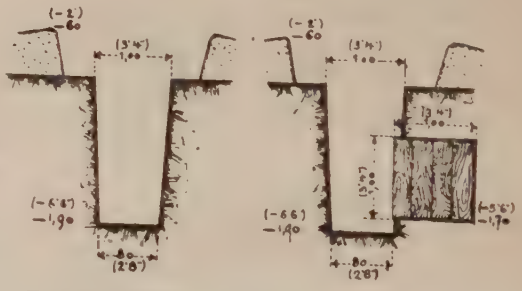


FIG. 93.—Section *C-D*, FIG. 94.—Section *A-B*, Ammunition recess, communicating trench.

near the mortar platforms to shelter a first reserve of supply. A protected observation post should be constructed between the platoons and in rear for the battery commander, in accordance with the principles given in Part IV.

48. *Emplacements with Overhead Cover* (Fig. 96).—The roofs should be constructed as for shelters for light field

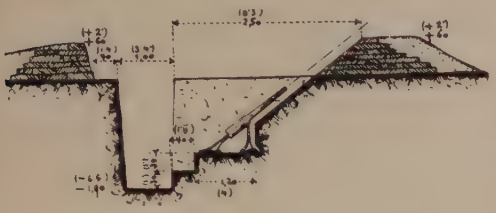


Fig. 95.—Section *E-F*, mortar platform.

fortifications. The type shown is formed of two layers of logs separated by a foot of earth and covered with sandbags and earth.

49. *Communication.*—A battery of light mortars is, like a machine-gun bat-

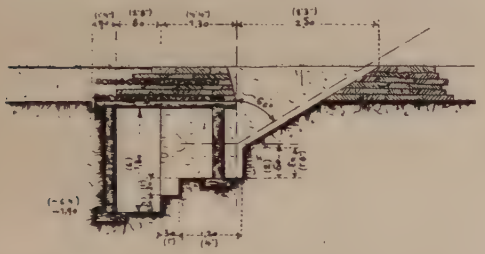


Fig. 96.—Emplacement for trench mortars with overhead cover.

tery, essentially a mobile unit, and should be constantly in communication with the infantry unit to which it is attached.

Part VI

Improving Living Conditions in the Trenches

50. *General Principles.*—Order and sanitary conditions must be rigidly exacted in the trenches, or they would soon become untenable or very unhealthy.

Command posts, telephone stations, first-aid stations, trench depots, kitchens, the supply of drinking water, latrines, and lavatories should generally be constructed in short, covered trenches at the angles in the approaches (Fig. 97).

For equipment, drinking water, rations, lanterns lighting sign-posts, etc., niches of various sizes are constructed in the parapet; or recesses, lined with timber, are constructed in the walls of the trenches and approaches.

Fig. 97.—Location of command posts, telephone stations, kitchens, etc.

51. *Command Posts* (Figs. 98 and 99).—Besides their combat posts in the firing trench, the various commanders should be provided with shelters called "command posts." Their size and arrangements will depend upon the grade of the commander who occupies them. They should be large enough to accommodate the commander and his assistants or staff who must be constantly with him. They must be located so that they can easily be found, even by orderlies of another command; the routes to them must be plainly marked, and their position shown by flags and colored lanterns if this can be done without being visible to the enemy.

Figures 98 and 99 show a company command post. The captain has a room 8 by 10 feet, and his lieutenants a room

10 by 13 feet. A telephone and some tools are placed in the lieutenants' room. The furniture consists of cots, benches, stools, and a table. Ventilation is secured by two pipes which run at an inclination to the surface of the ground, or by vertical holes over the wall of the shelter. The shelter is heated with a stove or fireplace in a recess in the captain's room. The stove pipe should run the entire length of the shelter so as to utilize all the heat.

The company command posts must have on each flank:

a. 20 yards to the right, a depot of rations, tools and sand-bags.

b. 20 yards to the left, a waterproof shelter for arms, ammunition, grenades, rockets, etc.

They should be plainly marked C. P. No. —. All material should be always collected and inventoried in these fixed and known points, and nowhere else. In each command post there should be a bulletin board of uniform model to record orders, and matériel.

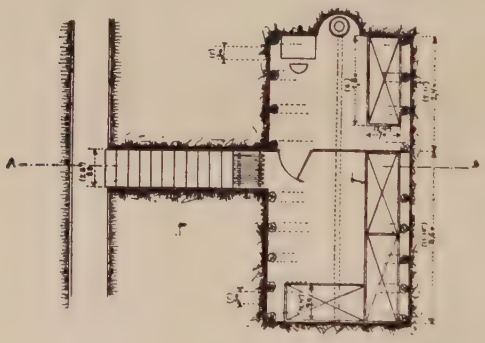


FIG. 98.—Plan of a company command post.

52. *First-aid Stations.*—These are connected with the fire trench by a communicating trench wide enough to carry a litter. They are constructed like other shelters. The walls are covered with straw mats or hurdle work, which must be changed frequently. They should be at least 8 by 12 feet in size. Two cots should be placed against one wall, and a bench for the wounded to sit on against the other.

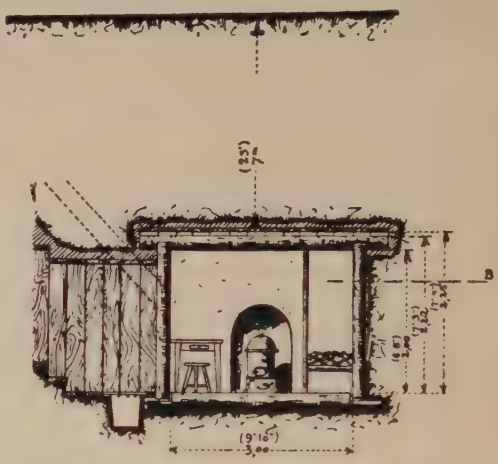


FIG. 99.—Company command post, section *A-B*.

53. *Kitchens.*—These should be constructed in shelters. The stove pipes should project somewhat above the top of the shelter to secure good draft. In addition, numerous ventilating holes must be made. They may be made large enough to accommodate the rolling kitchens. Small fires built of dry wood in the bottom of deep trenches do not betray the trenches.

54. *Latrines.*—It is absolutely necessary to construct latrines near the trenches and approaches. They may be without overhead cover as in Fig. 100, or with it as in Fig. 101. It is necessary to provide comfort and security. When practicable the place should be revetted with timber, and supports constructed. Cleanliness should be insisted upon, the deposits covered with earth daily, and the location changed when the pit is three-quarters full. The entrance trench should be paved with stones for at least 10 yards. The latrines should be ar-

ranged on the arc of a circle, five or six radiating from a central point, or in the form of a cross, or on both sides of

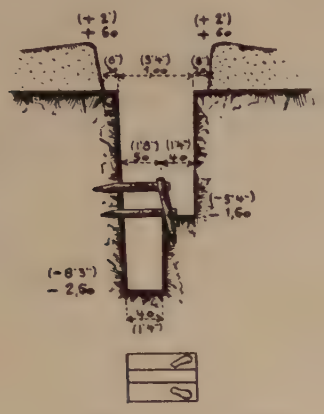


Fig. 100.—Latrine without overhead cover.

a special trench. The nearest latrines must be at least 30 yards from the principal approaches.

55. *Lavatories.*—These are improvised of tin or wood so as to form a

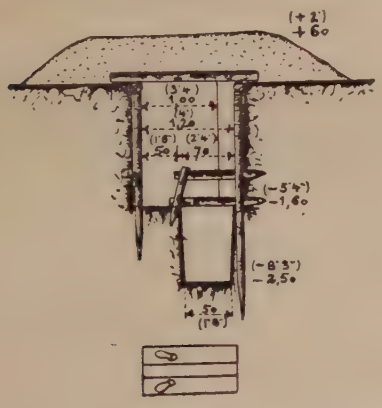


Fig. 101.—Latrine with overhead cover.

number of basins in a row, with holes in the bottom, placed above a wooden trough which receives and carries off the water to a cask or drainage pit. There should be a grating for the men to stand on. They should be constructed in a branch trench, covered if practicable. The floor of the trench should have a decided slope.

56. *Shower Baths.*—These should be installed in a deep shelter or in a cave shelter. A simple arrangement is to provide one or two kettles for heating water, tubs or casks for storing water, placed about 9 feet above the ceiling of the shelter. The tubs or casks should be connected with a pipe fitted with sprinklers, properly spaced. There should be a grating on the floor, and the bottom of the approach should have a fairly steep slope towards a drainage pit.

57. *Water Supply.*—This usually consists of several large casks filled with pipes if practicable, otherwise the water is carried to them. There should be an interval of at least ten paces between casks to avoid crowding and mud puddles.

CONCLUSION

58. The numerous works described herein would seem at first glance too complicated and massive to be ever constructed in actual warfare, but they are the results of actual experience in modern trench warfare, and numerous examples of them exist on the western front today. By means of work of this character the Germans have been able to hold the conquered portions of France with the minimum of men. Their bombproof shelters and the arrangements for the comfort and health of their men have especially occupied the thought of their highest commanders and engineers.

In many stances their captured underground works have been found intact in spite of bombardments by the heaviest artillery. Some of these shelters have been excavated to a depth greater than 40 feet, with galleries 150 yards long

and 7 feet high, completely lined with timber. On both sides of these galleries are large rooms, lined with timber, well ventilated by oblique shafts, and furnished with field cots with wire springs.

The timbering was so strong that in one case a 12-inch projectile which fell exactly over the top of the entrance did no damage except to crack a post. The exits are very numerous, and consist of six or seven stairways furnished with steel treads to avoid slipping, and several ramps with gentle slopes to permit of rapid exit in case of alarm. The shelters were heated with excellent stoves and lighted with electricity; the light and telephone wires ran along the walls, supported by glass insulators.

CHAPTER V

ORGANIZATION OF INTRENCHED ZONES

1. *General Principles, Definitions.* The organization of an intrenched zone comprises the establishment of elements of *frontal fire* and of *flank fire,* sweeping effectively the terrain.

These *elements of fire* take advantage of the natural accidents of the terrain: woods, houses, inhabited places.

The *elements of fire* are occupied by fixed garrisons designated by the commander whose strength varies with circumstances.

The group unit is generally the *platoon,* at the minimum a section.

Successive lines of elements of fire are established in rear of the first line, so that they may come into service as soon as the first line falls.

Hence elements of fire must be established in *breadth* and *depth.*

2. *Organization in Width—Strong Points.*—Group of elements of fire, so arranged that by their reciprocal support they will permit the defender to stop the assailant. The strong point is surrounded by a continuous obstacle, and may contain a redoubt.

It is always occupied by a constituted unit, commanded by its chief, who is held responsible for the constant repair and improvement of the defensive works, and of the defense of the place to a *finish.* The strength of this unit will depend on the importance of the strong points; it will generally be a company or a fraction of a company.

The strong points will be distributed along the front (width) according to the importance of the portions of terrain to be held and the facilities of assuring flanking dispositions.

3. *Organization in Depth.* — Fire power alone will not be always sufficient to assure the defense of a position; the defensive system must be organized so as to provide for immediate counter attacks, intended to retake all or a part of the last position. To this end, it is necessary to have:

(1) In rear of the first line of strong points, other strong points intended to limit any success of the enemy.

(2) Troops in reserve intended for counter attacking.

4. *Organization in Width and Depth —Supporting Points.* — The strong points are therefore grouped in width and depth. These groups take the name of *supporting points.* Their defense will be entrusted to a fraction (battalion or group of companies) placed under one commander, who will furnish the garrison of the different strong points and the reserve troops. Artillery may be allotted to certain supporting points.

The supporting point is surrounded and partitioned by systems of barb wire; it always has a redoubt, made up of one or two strong points.

The necessity of establishing as many as possible *continuous lines of trenches* has been demonstrated by the war and consecrated by the Battle of Verdun. The isolated strong points, separated by uncovered or almost uncovered intervals, are easily located by aerial photography and become, during the

preparation of an attack, the favorite targets for artillery. Moreover, the absence of continuous lines prevents the rapid occupation of the intervals by the defenders and permits the enemy to filter in between the strong points.

The continuous line does not suppress the strong point, but the latter must be sunk in a network of trenches, zigzags and false or dummy trenches.

5. *Sector.*—The union of several supporting points under the same command forms a sector. Each sector disposes always of its own reserves distinct from those of the supporting points. It has generally some artillery.

6. *First, Second, Third Positions.*—The first position of a defensive organization then consists of a line of supporting points. In war a second position will always be organized, and, when necessary, a third, constructed as the others. The distance between these positions must not be less than from 1 to 2 kilometers. It may even be greater when circumstances demand.

Each position comprises several lines united by numerous zigzags and partitioned by wire entanglement. Arrange in the entanglements of the second and third lines passages which will allow movement of the reserves (reinforcement, counter-attack).

Part I

Trace of the Firing Line

7. The first thought must be given to creating a powerful front by installing a solid fire line. Its trace, resulting from the emplacement and orientation of each element, must satisfy successively the following conditions:

(1) Organization of flanking dispositions.

(2) Installation of accessory defenses.

(3) Simultaneously: (*a*) Rectification of the trace of the position; (*b*) search for and installation of observations; (*c*) construction of trenches; (*d*) clearing up and range finding of the field of fire.

(4) Construction of communications.

(5) Construction of shelters and incessant reinforcement of trenches, shelters and observatories.

8. *Organization of Flanking Dispositions.*—A firing line is defended better by flank fire than by direct fire.

The near flanking dispositions must be carefully and methodically studied, as soon as a position is chosen. These flanking dispositions are organized in such a way:

(1) That they cannot possibly fire into their own line.

(2) That they are as much as possible sheltered from frontal sight and fire of the enemy.

9. *The Machine Gun Is the Flanking Arm.*—The majority of the machine guns with their personnel are placed in shelters, in very deep saps. At the end of the bombardment the men bring out the piece and set it up on the emplacement, if it still exists, or along the trench parapet, unprotected.

Examples of flanking dispositions suitable to each element: (*a*) In the first place, the trenches are broken in trace so as to adapt them as much as possible to the terrain, while flanking each other mutually.

Fig. 1 gives a scheme of ensemble of a broken trace.

A careful examination of the figure indicates very clearly the ensemble of the flanking dispositions.

Fig. 1.—Scheme of ensemble of broken trace.

Fig. 2 gives some details of organization of the flanking arrangements. The machine guns *M* and *M'* are sheltered from direct view and fire by epaulements. The normal wire entanglement is interrupted in their sector of fire, and a low entanglement is installed there, which will not be cut down by their fire.

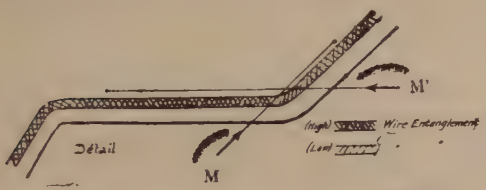


Fig. 2.—Flanking arrangements (details).

(*b*) Small salients (Fig. 3) are frequently and advantageously employed.

This "forward traverse" (Fig. 3) must be, at least, 6 meters in thickness at the base (along the trench), 4 meters at the top. The lateral branches are 4 meters long. The branches forming a redan are each 2 meters long. There can then be made a passage in rear to facilitate movement. The fire trench of the salient must be very narrow (2 feet 8 inches).

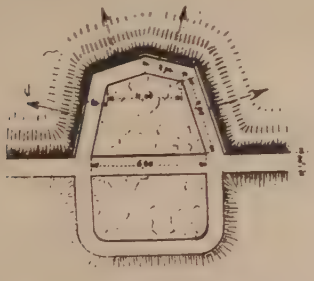


Fig. 3.—Small salient or forward traverse.

(*c*) From the position, short standing trenches are carefully constructed, sheltered by a strong parados against the fire of the neighboring elements of the general fire trench.

Flanking detachments are installed in these trench elements (Fig. 4).

Fig. 4.—Element of forward trench.

(*d*) The terrain may require the establishment of special advanced organizations. These positions are occupied by groups of firers.

An approach trench connects the arrangement with the first line trench (Fig. 5).

Fig. 5.—Special advanced organized position.

(*e*) It may be necessary to push a special trench element forward, so as to sweep a ravine, a valley, or a depression of the ground which cannot be seen from the first line. The approach

Fig. 6.—Element of forward trench.

trench of this position will serve for flanking a part of the principal front (Fig. 6).

(*f*) Finally, in woods, it will be logical to adopt the tenaille trace (Fig. 7).

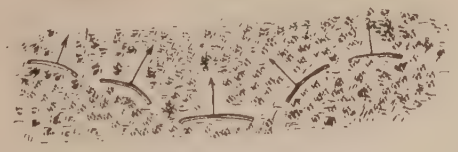


Fig. 7.—Tenaille trace in woods.

The positions will be selected so as to be invisible through the woods and from aircraft above.

(*g*) From center to center the flank fire is assured by the installation of flanking detachments in effective emplacements. The flanks of each trench should not be covered by any other. Each should be solidly supported on its flanks so as to avoid enfilade fire and being turned.

Establish liaison by rifle fire and communications by defensive approach trenches, with neighboring organizations to right and left.

(*h*) Finally, so far as the artillery is concerned, the batteries from the beginning must be placed relatively far forward; it is only from advanced positions that artillery can possibly give a flanking fire for neighboring sectors.

(*i*) If in the night installation of positions the broken trace lines cannot be obtained, flank fire may be obtained, after building the trenches, by sapping outstanding trenches. However, take care that the enemy may not be able to enfilade them.

10. *Construction of Accessory Defenses.*—Infantry, of good morale, can repulse all attacks if it has a good field of fire of 50 meters in depth and if the progress of the enemy is retarded by accessory defenses.

(NOTE.—The construction, installation and destruction of accessory defenses are the objects of special lessons.)

Commence by putting down the entanglement the farthest away so as to prevent the use of flame projectors. Use the counter slope a great deal, the low places, woods.

11. *Simultaneously*—(*a*) *rectification of the trace of the position.*—Under the protection of the fire of the first line which has dug in when it was forced to stop, the emplacement of the position is chosen in such a manner that the firing trenches are hidden from view as much as possible and consequently unexposed to artillery fire. The emplacement should be such that supplies and reinforcements can come up under cover.

The different solutions which take into account at the same time the field of fire and cover, present each advantages and inconveniences.

Take two crests *XY* of considerable relief, separated by a valley *V* (Fig. 8).

(1) *Position at the foot of the slope at B.*—Good field for sweeping fire, emplacement hidden from artillery *M*, but dominated by the enemy at *K*; moreover, the movements of reinforcements from the crest will be difficult.

(2) *Position at C, on the military*

FIG. 8.—Emplacement of defensive positions.

crest.—Good commanding position. Good fire effect, sweeping on *CB*, plunging on *BPK*.

But the hostile artillery will regulate easily its fire on *C;* the movements on *DC* will be difficult; the trenches inclined on the slope will be very vulnerable, solution sometimes imposed by reason of the long views. It is always indicated for advanced combat posts. The installation of a line of surveillance or of machine guns could come from behind the crest by saps pushed under the crest.

(3) *Position at D on the real or topographical crest.*—Good views on distant debouching points *NKE*. Easy to hide if care is taken to place the trenches at 30 or 40 meters in front of the crest to avoid outlining the parapet against the sky.

Movements to the rear easy and hidden from sight. Very easy solution in moderately undulating ground. In rough country, the slope *CD* being very steep and short, the topographical crest presents the same difficulties as the military crest.

(4) *Position at E, on counter slope.*—Possesses a very short field of fire, is dominated by the terrain in front, but offers a considerable advantage; it is completely sheltered from view and from infantry fire. Hard to locate, and so little exposed to artillery fire.

The friendly artillery on the contrary can lend, by barrage fire on the crest, considerable and accurate support to the intrenched infantry; on the other hand, the enemy debouching from the crest, received by the fusillade and stopped by the wires, hidden from sight by the counter slope, undergoes a considerable effect of surprise, which is all the more demoralizing for that reason.

These trenches on the counter slope lend themselves admirably to close combat. Occupied by defenders of solid morale, protected by thick accessory defenses, they permit of stubborn and long drawn out resistance, even when held by weak effectives. The counter attack, launched at the moment when the enemy, surprised, stops, hesitating, against the entanglement, will have sure results. With this arrangement, a line of surveillance must necessarily be placed at *C*. Machine guns placed on this line, and capable of circulating on cover between *C* and *E*, will produce very powerful and deadly effect.

The advantages of organized positions on counter slopes have been consecrated by the war and particularly by the defense of the advanced positions before Verdun. Their advantages may be summed up by quoting Col. Piaron de Montdésir:

> Formerly, with arms of short life, and slow loading, it was necessary to have a range long enough to permit reloading. This reason no longer exists. Modern arms have a long range and load quickly, several shots being introduced at a time, thanks to the magazine. Long range fire may be utilized by the advanced combat posts and caponier trenches. It suffices to utilize rapidity of fire to obtain by the factor time what used to be obtained by the factor distance. Moreover, the effects of fire at short range are much more sure. The fire would not be good if the riflemen were subjected to the neutralizing fire of artillery, but, having escaped this, and only receiving a fire which they oppose by their own, their cover gives them a marked advantage. (Col. Piaron de Montdésir: "Essay on the tactical employment of field fortifications.")

(*a*) *Choice of emplacement.*—The importance of a free and extended field of fire is secondary to that of the infantry, being sooner in its combat position; a position, excellent for intrenchment, may have a limited field of fire. If the frontal accessory defenses are solid, a field of fire of from 200 to 50 yards and even less (30 yards in Argonne) is sufficient. A commanding position, chosen so as to obtain an extended field of fire—for example on the slopes of a line of heights facing the enemy—is generally to be avoided.

It is of the greatest importance that the fire trenches should be hidden from sight as much as possible, and, consequently, exposed as little as possible to artillery fire. Access should be possible under cover. Therefore it is recommended, in open country, instead of placing fire trenches forward of the crest, to place them somewhat in rear of the crest.

The infantry, then, in the choice of its positions, is considerably more independent than formerly. Only, it absolutely must seize the parts of the terrain which serve for the observation by the friendly artillery.

(*b*) *Search for observatories.*—The search for emplacements which give good views over the hostile position is of the highest importance. Flank views are particularly interesting. Observatories provided with means of optical and telephonic communication will be installed in trees, ruins of houses, straw stacks, and on all elevated points giving wide views.

If there are, forward of the position, points which permit the enemy observers to see into the friendly position and in rear of it, an effort must be made to find out whether, from the advanced positions, these points can be taken under an effective fire. The possession of cover in advanced terrains, such as houses, mills, which protect the hostile artillery observers, must be disputed desperately.

(*c*) *Construction of trenches.*—The trenches along the trace staked out are constructed according to the principles explained in a former lecture. The workers are hidden from distant sight by a parapet mask made of branches and brush. The work is done simultaneously with the range finding and the clearing up of the field of fire.

(*d*) *Clearing up and range finding of field of fire.*—The clearing up consists in removing or levelling crops, brush, small walls, houses even, to facilitate direct and flank fire.

A field of fire is *range-found* when fire can be opened with the exact sight setting, or visible objects in it. Employ, for range finding, observation by avion, reconnaissance by range finding parties. Use carefully and rapidly the information obtained. In woods, remove to the height of a man the bark of the trees in the field of fire on the side toward the friendly position. Whitewash this face. In this way, at night, the visibility of attacks or hostile patrols is augmented.

12. *Construction of Communications.*—Every defensively organized position must be provided with organs of communication, which will allow the rapid upbringing of supplies and reinforcement which, covered from distant view, is effected either by following defiladed routes, or by the way of the approaches, where trace, construction and arrangement have previously been treated. The number of these approaches will be de-

termined in Part IV of the present lecture.

13. *Creation of Shelters and Reinforcement of Works.* — Create, for troops of the line of fire, combat shelters on this line, and for the available troops and the reinforcements deep solid shelters in deep saps, with defiladed communication towards the rear.

Part II

Element of Platoon or Section Trench and Group of Elements of Trench

14. Groups of trenches are generally constructed for one company. They are composed of platoon trenches, or section trenches, whose intervals are connected by observation approach trenches with fire crests (defensive approaches).

The group of several elements of platoon or section trench will constitute a company group.

15. *Platoon or Section Trench.*—It will be built generally, and exception made of flanking dispositions already indicated, in the form of a flattened lunette, having approximately *50 meters of trench available for fire.* (Fig. 9.)

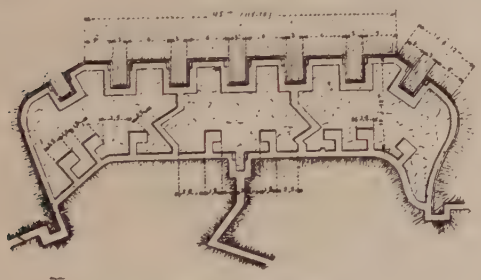


Fig. 9.—Element of platoon trench.

Distance between traverses, 6 to 9 meters, which may in exposed places be reduced to 4 or 5 meters, 2 to 4 meters thick at the top. The total length of the front of the trench, with 5 traverses in front (every 6 meters) and one traverse on each flank, will be about 70 meters.

The length of the excavation will be from 85 to 90 meters.

The face, or front, properly speaking, with its five traverses, will have a total front of about 45 meters (32 meters of fire crest). Each flank will have from 10 to 12 meters of development, including a traverse of 3 meters.

Do not place traverses at the salients. Stake out the traverses adjoining a salient at from 3 to 5 meters from it.

The section trench will have the half of the development of the platoon trench, but will comprise the same elements.

16. *Group of Trenches for a Company.*—The platoon trenches will communicate (Fig. 10):

(*a*) *Between themselves:* by means of the approach trenches of surveillance, prepared as a defensive approach.

(*b*) With the rear and the command post of the captain, by the approaches.

The trenches of the different companies communicate with each other at first only by the rear, then lateral communications are established, and these are prepared as defensive approaches. A continuous line of trench is thus established along the whole front.

The development of the 4 platoons may occur when the battalion reserve, situated 200 or 300 meters in rear, may make its action felt rapidly; if not, the company field work comprises but three trenches in the first line.

17. *Group of Trenches for a Battalion.* (Fig. 11.)

18. *Group of Trenches for a Regiment.* (Fig. 12.)

19. *Group of Trenches for a Brigade.* (Fig. 13.)

Part III

Plan for the Organization of a Supporting Point

20. The organization of a supporting point is, in each particular case, a problem whose data may, and whose solution will, depend on the military situation, the terrain, the time, the workers and material available, etc. No precise rules of organization can be given, but only guiding principles. These principles are outlined in the figures representing the organization of works for a company, a battalion, a regiment, and a brigade. (Figs. 10 to 13.)

The organization comprises the establishment of successive lines of defense, the permanent installation in these lines of fractions intended to assure its defense, or to constitute counter-attack troops; it comprises finally the largest use of approaches, shelters, wire entanglement, platforms and shelters for machine guns and trench weapons, so as to limit the enemy's advance and to retake, by counter attack, the ground lost.

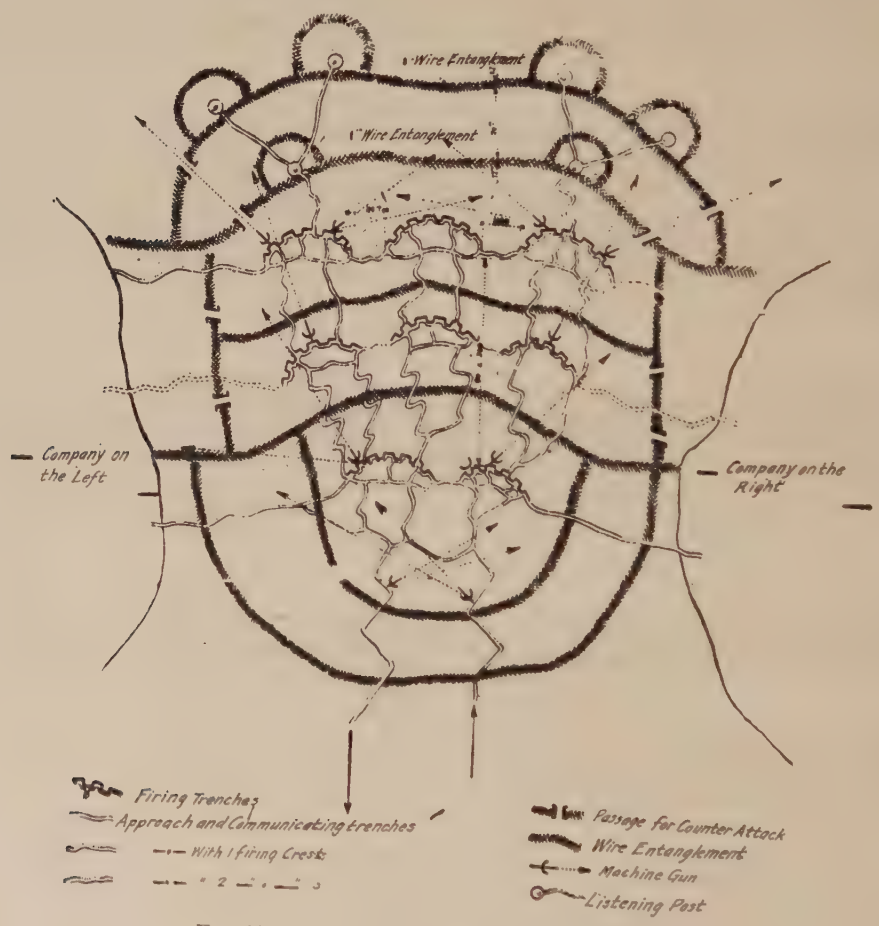


Fig. 10.—Group of trenches for a company.

21. *Successive Lines of Defense.*—The successive lines of trench bear the following names:

(1) Firing trenches.
(2) Support trenches.
(3) Intermediary trenches.
(4) Reserve trenches.

22. *Firing Trench.*—It is the emplacement where the advanced fractions receive the first shock. They permit the garrison to utilize, to a maximum, its force of resistance and to weaken the enemy considerably so as to prepare the counter attack.

They are sometimes double. This method permits an immediate counter attack, and in case of intense bombardment, a rapid retreat of the garrison, which, however, is held near. This trench is called the cover. It is generally at about 40 meters from the first line.

The firing trenches, covered by a large zone of accessory defenses, must be preceded by advanced post trenches, or at least rifleman's pits, likewise pro-

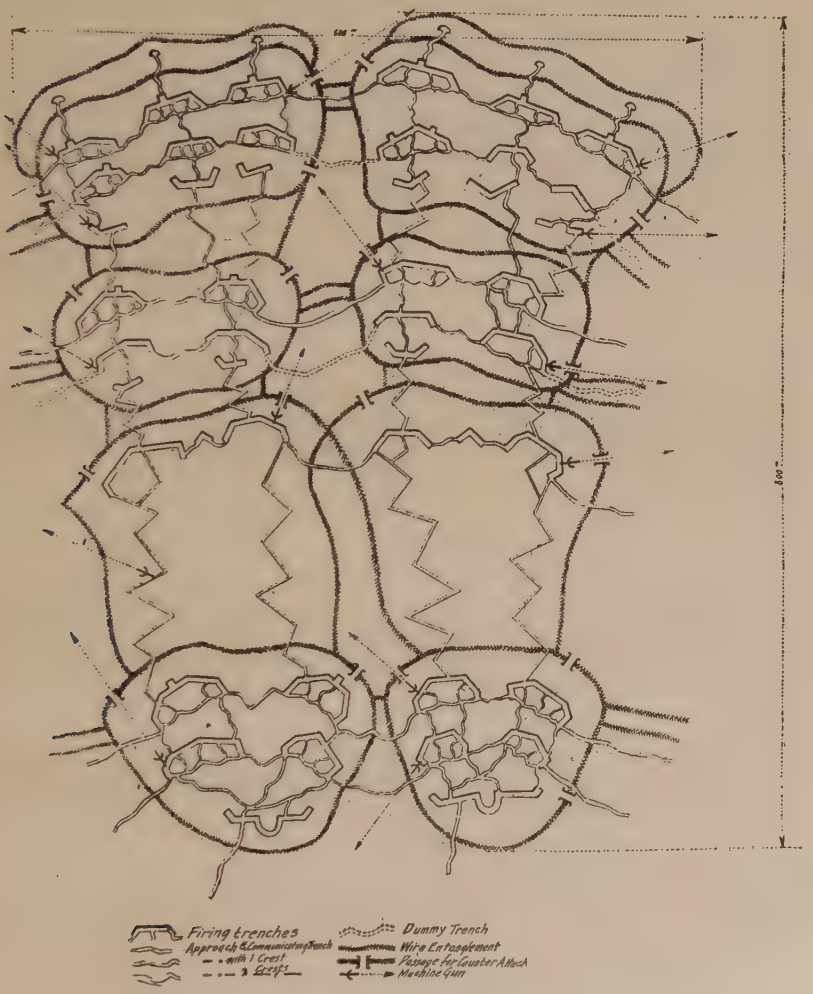


Fig. 11.—Group of trenches for a battalion.

tected by accessory defenses. These intrenchments permit:

(*a*) To watch over the accessory defenses, and to hold at a distance the observers and the hostile sharpshooters.

(*b*) To prepare, by assuring the advanced surveillance of the terrain, the task of the patrols and sudden enterprises, which assure the mastery of the terrain.

(*c*) In case of attack, to oppose to the enemy a first resistance. They assure thus the opening up of the flank fire, and they give the commanding officers the necessary time to prepare and spring the counter attack before the first line is reached.

23. *Support Trenches.*—The line of the support trenches will be established at from 100 to 200 meters in rear of the

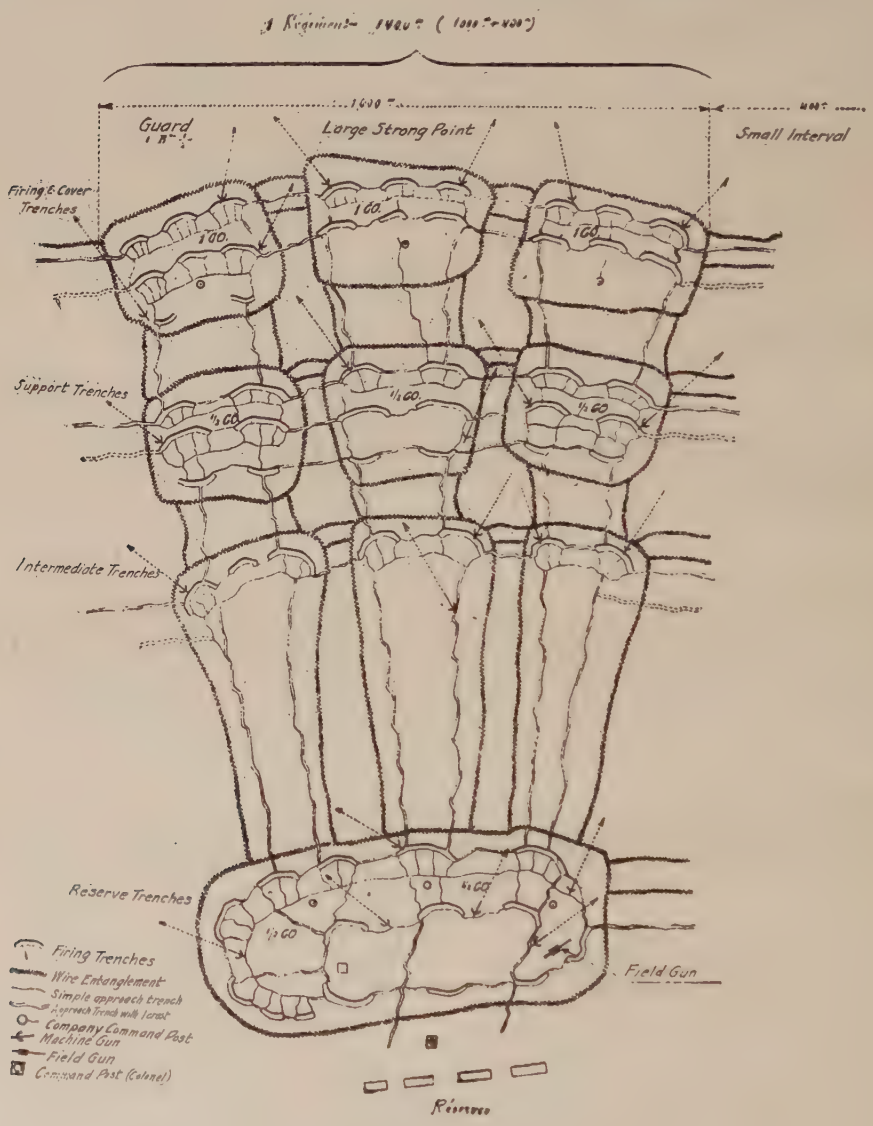


Fig. 12.—Group of trenches for a regiment.

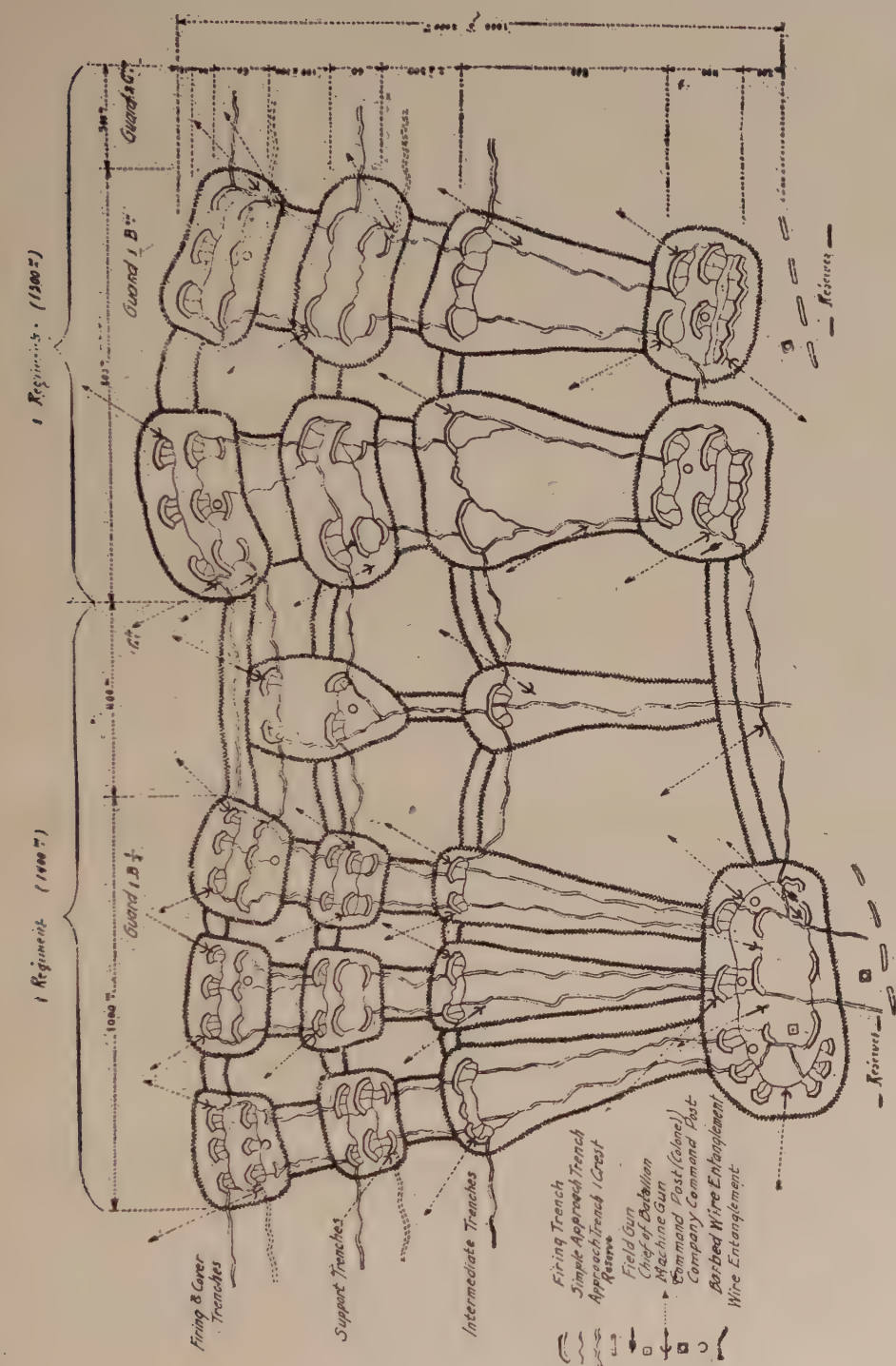


Fig. 13.—Group of trenches for a brigade.

trenches of the first line, and should hold them under its fire. They permit, in case of the yielding of the first line, to limit the recoil. Their defense gives the available troops of the sector time to counter attack. They must hold the first line trenches under their fire. Each one is preceded by a wire entanglement. In case of attacking, they play the rôle of parallels in rear of the first line for the third and fourth waves of attack.

24. *Intermediary Trenches.*—One or two intermediary lines will be organized in rear, likewise at 150 or 200 meters one from the other, sweeping as much as possible the trenches in front and the communications which connect them; they will be developed according to the terrain. They permit:

Sheltering momentarily the available elements of the sector;

Limiting the zone in which an entering enemy could spread out.

All the trenches, whether advanced, of the first line or of the second line, are provided with look-outs, whose mission it is to alarm their comrades, to start the barrage or to repeat the signals of the first line.

25. *Reserve Trench.*—Finally, in rear of the supporting point (400 to 1,000 meters), a solid redoubt, completely closed. If the terrain demands it, it can be divided into two distinct works, both closed. The rôle of the redoubt is to offer to the enemy a last resistance, pushed to the limit, to interfere with his movement and his establishing himself on the terrain which he has won, and to favor the counter attacks made by the sector reserves. The redoubt is formed either by a natural position or by an artificial construction.[1]

The emplacement of the redoubts is, as much as possible and as closely as possible, defiladed from distant view, and hidden from aerial observation; it contains well-constructed accessory defenses, shelters for the reserves of the center of resistance, considerable supplies (5 days at least) of food and ammunition, as well as the command post of the commanding officer of the center of resistance.

The custody of the redoubt will be entrusted to an energetic chief, who will fight to a finish.

26. *Communications.*—A system of communications, easy and well-defiladed routes, will facilitate the life and defense of the center of resistance. The different echelons of trenches are connected with each other by very deep and narrow trenches, arranged for observation and defense foot by foot. Avoid long, straight elements, and put in many traverses.

The communications are covered by accessory defenses, placed in the immediate proximity of the trenches so as to obstruct them immediately (*chevaux de frise*, sandbags, etc.). Along the

[1]In the offensive in Champagne in September, 1915, the French found themselves stopped by redoubts organized under ground, having the form of a star and which were called for that reason *star* redoubts.

At about 10 meters below the ground is a cave shelter of vast dimensions, in which is lodged a company and are stored machine guns, trench weapons and several days' rations. Five or six trenches executed by a very deep sap, without any relief, or by a mine gallery, radiate in all directions and come out at the surface of the ground. The exits form half a dozen points on the imaginary circle of a radius of 100 meters.

In each trench or gallery a railroad permits the rapid movement of weapons and ammunition.

At the exit, holes with parapet effaced, for trench weapons and machine guns, with emplacements carefully chosen so as to sweep the exits.

Moreover, these redoubts are mined and can be blown up from any one of the exits.

route, branches are constructed, where platforms, shelters for machine guns and trench weapons are installed. According to the position of these communications, whether on the axis or on the flanks of the supporting point, they are prepared with single or double fire crest.

Number.—Between the fire trench and the last support trench there must be at least one approach per element of platoon or section trench.

In rear of the last support trench and for every 300 meters of front, two approaches, at least, for the forward movement; a third approach for evacuations and the movements towards the rear (evacuation approach). This approach must have a trace and profile which permit the easy passage of the litters. It is on the route of this third approach that the protected first-aid stations will be branched.

The approaches in rear of the supporting point must be pushed to 4 or 5 kilometers, according to the terrain. They must permit the circulation of 2 men abreast, but they will then be deepened (2 meters at least) and carefully constructed at the angles, so as to assure sufficient protection. Recesses with exit steps will be arranged every 100 meters so as to facilitate circulation, and in case of need, a rapid exit.

The approaches will be connected, as closely as possible, to the command posts and observatories.

27. *Shelters.*—The shelters will be sufficiently numerous to shelter during bombardment the whole of the occupants of the supporting point, with the exception of the observers and the indispensable look-outs, themselves placed in each line of defense under defiladed and protected observatories.

The commanding officer must see to it that these shelters are unceasingly improved so that they can resist projectiles of 210 mm. and their living conditions become better.

28. *Assembly Point—Preparation of counter attacks.*—The preparation of counter attacks will be studied with care, under the most probable hypotheses; their success will depend upon their suddenness and violence.

Special shelter of assembly points will be established for the partial reserves of each strong point and for the reserve of the supporting point, in emplacements chosen so as to act rapidly towards the menaced points.

Communications issuing from these shelters will connect them to the general system of communications. Moreover, communications or special exits will be created for counter attacks (ramps, steps, facing the enemy). In particular, oblique passages well enfiladed by the trenches in rear will be opened in the accessory defenses.

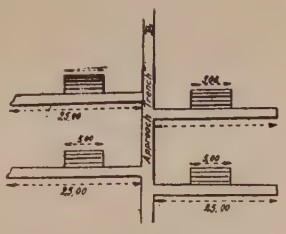


Fig. 14.—Four assembly points for section.

The arrangement to be given to the assembly points will be essentially variable. While providing for the troops the best shelter possible (in general 2 meters in depth and 1 in width), measures must be taken to provide them an easy way of debouching (Figs. 14 and 15).

In the preparation of a terrain, in

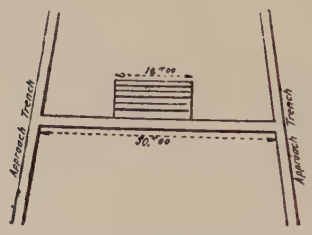


Fig. 15.—Assembly point for platoon.

view of an attack, the troops designated for the attack will wait for the instructions of the chief concerning the preparation of the assembly points.

29. *Command Posts.*—Strong and supporting points have each a command post connected electrically with the front (trenches), with the rear (higher command and the artillery), with the neighboring strong points, and with the command post of the supporting point.

Each office of command of a supporting point must be connected with the neighboring supporting point, and with the commanding officer of the section.

The command posts must be easily found, even by liaison agents of other units. Mark out clearly the itineraries, mark the emplacements, for example, by day, with flags, by night with colored lanterns, or any other special sign, *visible from the approaches,* but defiladed from the enemy's view (small niches).

30. *Telephone Connections.* — They are of two kinds:

(1) Communications for the officer of command established by the telegraph sappers.

(2) Interior communications between units of infantry and artillery or connection infantry and artillery, established by the regimental telephonists. Fig 16 gives an example of the logical organization of a sector, held by a regiment of three battalions, having each three companies in the first line. The regiment must, as a rule, connect up with the brigade and with the groups of light artillery which operate on its front. The brigade post is in general organized by units of telegraph sappers.

31. *Trench Weapons.* — Numerous trench weapons (trench cannon, special mortars, lance bombs) will be installed in the center of resistance. The emplacements can be prepared in the trench itself. But it is preferable to dispose these weapons in special emplacements, branched on the approaches. The emplacements must be hidden with the greatest care to avoid being located by the enemy. Each emplacement must be completed by shelters for the personnel and the ammunition.

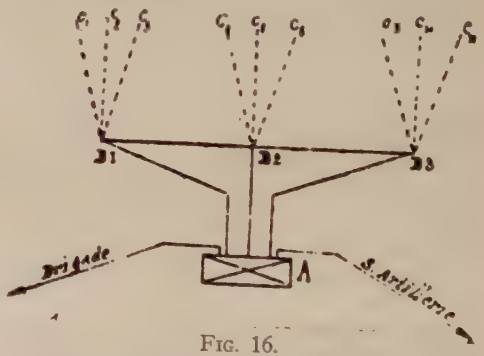


Fig. 16.
A. Command post of the colonel.
B. Command post of the battalion commander.
C. Command post of the captain.

The emplacements must be numerous, in number superior to that of the batteries available, so as to displace and use elsewhere the weapons that may be located by the enemy, and in order to concentrate on certain points strong batteries.

32. *Artillery.*—There may be allotted to the supporting point for its own use some field pieces intended for flanking. These pieces are always sheltered under casemates. If they utilize uncovered emplacements, the pieces will be kept in waiting in bombproof shelter. These pieces generally work for the benefit of a center of resistance other than that in which they are installed; a special telephone line must establish the necessary communication.

33. *Organized Defense of Intervals.*—These are zones organized for defense, not much occupied in normal times, comprised between two strong or supporting points. They must be swept by fire and watched carefully. These intervals are generally chosen on account of the difficulties that the terrain offers for the enemy's progress by reason of natural obstacles (marshes, low-lying land, rocky ground). An interval never comprises an empty space. It comprises especially:

(*a*) A continuous obstacle consisting of accessory defenses which will be rendered as strong and as impenetrable as possible, with passages arranged for friendly patrols and attacks.

(*b*) In rear of these defenses, an observation approach trench prepared as a fire trench, constituting thus with the first line trenches strong points connected up—a continuous line of trenches. The continuous line, in addition to preventing the enemy from filtering through, removes from the defender the idea of being isolated in his strong point.

In case of attack by the enemy, the interval is garrisoned, and the density of the defense becomes equal to that of the works of the strong points or of the neighboring centers of resistance.

Part IV

Defensive Organization of a Sector

34. A position is constituted by a line of supporting points.

But these supporting points are themselves grouped rationally so as to constitute sectors each occupied by a big unit: Army Corps Sector, Division Sector, and, where necessary, Brigade Sector.

The sectors, according to tactical circumstances and the terrain, may have very unequal extents and comprise a variable number of supporting points.

In addition to the work executed in the supporting points and in intervals between them, the defensive organization of a sector will comprise a certain number of works of general interest, for example:

(1) *Communications* (development of a good system of routes, installation of railroads of 2 feet and 1 foot 8 inches gauge).

(2) *Shelters for sector reserves* (natural shelters prepared and improved).

(3) *Emplacements for field and heavy artillery* (masked, protected: the protection may be very great by the use of concrete).

(4) *Boom-proof storerooms for ammunition and explosives.*

(5) *Barracks and sheds for men, horses and matériel.*

(6) *Arrangements* of all kinds in the rest cantonments.

The commander of the sector has at his disposition sector reserves and artillery, which is assigned to him as his own, independently of that which may be in his sector, but whose use is reserved to the higher command.

A telephonic and telegraph system

well kept up, having its center in the command post of the commander of the sector, will connect them up:

(*a*) Towards the front with the commanders of the different supporting points of the sector.

(*b*) Laterally with the commanders of neighboring sectors.

(*c*) To the rear with the higher command of the organization.

Part V

Organization of the second and third intrenched zones

35. In rear of every intrenched zone there must always be established an intrenched zone which will be constituted in an identical fashion to that of the first: supporting points organized in depth and group in sectors. It must be studied and organized, entirely independently of the first zone, in the best conditions for its own defense.

The second zone must be stronger than the first; its place can be selected and studied better, better flanking dispositions, the accessory defenses more solid and more complete, the shelters more carefully constructed.

The distance from the first to the second zone is variable. The latter must be chosen in such a manner that the enemy, from the same emplacements, cannot prepare an attack simultaneously on the first and second positions. Invisibility must be sought. Traces in woods and on counter slopes must be used.

A third zone may be established in rear of the second and according to the same principles.

According to circumstances (importance of a sector, menace of the enemy, workers available, materials, etc.) it will be organized more or less completely, or only in its essential details.

In any case the study of the terrain must be made in the greatest detail, so as to at once complete the organization at the first order.

Part VI

Distribution of troops

36. The troops assigned to the defense of a sector are divided in the following fashion:

(1) On service in the trenches three-eighths of the total effective, of which two-eights in the fire trenches, one-eighth in the support trenches.

(2) In sub-sector reserve two-eighths of the total effective. The troops at rest in the shelters or cantonments counted in the sub-sector.

(3) In sector reserve: three-eighths of the total effective. The troops at rest in the cantonments situated at 4 or 5 kilometers from the fire trenches.

37. *Troops on Service in the Trenches.*—These troops have a rôle of advanced posts with reference to the troops in rear available. In this capacity they must:

(1) Protect by assuring the solidity of the front.

(2) Get information for and prepare the attacks by direct observation, the sending out of patrols and the execution of sudden enterprises.

By day they have look-outs under protected observatories.

By night, a fraction of a quarter (2 officers, 4 to 8 look-outs, one squad by section) watch and observe in the listening posts, run out fan shape beyond the wire entanglements.

The rest of the garrison rests, repairs or improves the fortification, which must be constantly perfected.

The rapid execution, complete and careful, of field fortification involves the military honor of the troops in charge of it.

Any chief who tolerates a regiment working little or badly, under any pretext, is wanting in the first duty of his office.

Part VII

Special Defensive Organizations

38. *Blockhouse.* — Blockhouses are elements of strong points organized so as to obtain with a small force a strong resistance and good flank fire (Fig. 17).

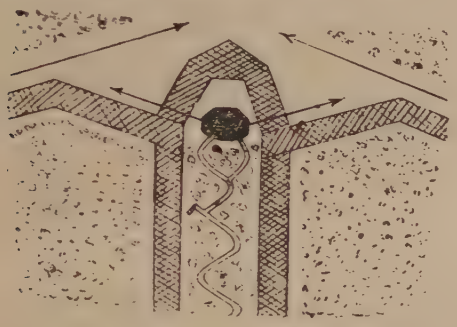


Fig. 17.—Plan of the work and accessory defenses.

In their entire make-up, they are generally constituted by covered trenches, with loop-holes for fire and emplacements for machine guns. The roof is made by a layer of logs of 0.20 m. diameter or railroad rails surmounted by a layer of earth which varies with the relief allowed.

The relief of the blockhouse must be slight, so as to diminish its visibility, unless natural masks hide it. There are many types of blockhouse.

Figs. 17 and 18 represent a blockhouse for a squad with machine guns on one flank.

For the details of construction of covered trenches and of shelter for machine guns, see the special chapters, Third Lecture.

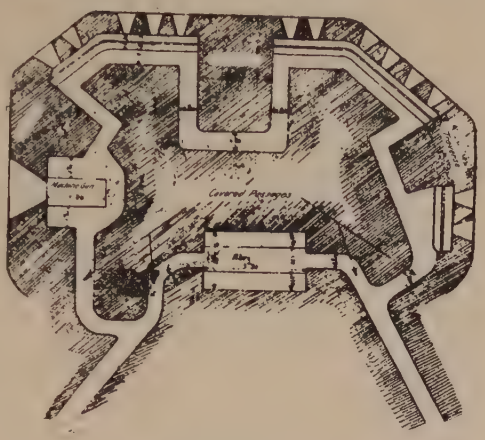


Fig. 18.—Plan of blockhouse indicated in the arrangement above.

39. *Closed Fire Trenches.*—Often it may be necessary to fortify in rear of the first line a special strong point. If there is no ground cover (patches of woods, villages, farms, houses, etc.) closed fire trenches may be organized (Fig. 19).

Fig. 19.—Plan of an aisle of closed trenches.

The approach trenches permit the circulation between the front and rear part of the fire trenches, as well as with the exterior.

Protected shelters and cave shelters very largely stocked with provisions and ammunition allow prolonging the defense to the limit.

INHABITED PLACES, VILLAGES

40. *Importance.*—They constitute important natural strong positions. Bloody episodes of the present war (Vermelles, Carency, Souchez, Ablain, Saint-Nazaire, Tahure, Pozières, Contalmaison, Thiepval, Combles, etc.) offer a *mask, cover,* or *obstacle,* and *communications.*

Mask.—Permits concealing the reinforcements, especially in flat country. The probable force of the defenders is unknown.

Cover.—Against artillery: the first houses provoke the burst of projectiles and stop the fragments of burst.

Against infantry: infantry fire is ineffective against walls 14 inches in thickness.

Obstacle.—To the movement of troops, it is difficult to debouch when the exits are under hostile fire.

Communications.—The localities are situated at the points of convergence of the roads and routes and command the lines of communication.

41. *Defensive Organization—Generalities.*—Big explosive projectiles have considerable effect on villages which can be seen from afar. But whatever may be the effects in the majority of cases, even after a very intense bombardment, parts of the edges of the town intact, walls left half standing, piles of débris which permit a fight foot by foot when the enemy is too close to continue firing. It is then indispensable to provide for the defensive organization of localities, and they must not be left out of the line of defense.

This organization must be arranged with a view to putting the defending troops under shelter from the destructive effects of projectiles. To this end it is necessary to consider several principal cases on the subject of the emplacement of the principal fire crest.

42. *Edges and Approaches Seen from Afar and Easily Located by the Hostile Artillery.*—The village is considered as a cover or mask, the edge prepared as a passive obstacle which will be organized only in view of a close defense, when the hostile artillery having lengthened its fire, it will be possible to occupy the village.

The principal fire crest must be established forward of the prepared edge of the town.

The exterior edges of the town are occupied: hedges, palisades, banks, ditches, which are at *50 to 150 meters* in advance; at the same time, seek an open and extended field of fire, utilizing all the salients for flank fire, either by groups of riflemen or well-sheltered machine guns.

43. *Edge of Town Defiladed from Distant Views* (case of a village on a counter slope or in bottom of a depression). Organize the principal fire crest on that edge of the town which gives a good view and permits a very rapid and very solid organization.

Prolong this fortified edge by entrenchments for flank fire on the intervals and cross fire in front of the edge of the town; barricade the exits.

44. *Edge of Town at Very Short Distance from the Enemy* (current case in trench warfare). The considerations of the field of fire are the only ones of interest. If from the edge of the buildings of the town the terrain can be well seen to 100 and 150 meters, it is organized; if not, the fire line is carried forward so as to have better views on the enemy's position.

As the village can be subjected to an accurate and intense bombardment, the

occupants must be protected by solid shelters built in the cellars and underground constructions.

45. *Particular Cases.* — Where the locality has a small front towards the enemy (village elongated perpendicular to the front). (Fig. 20.)

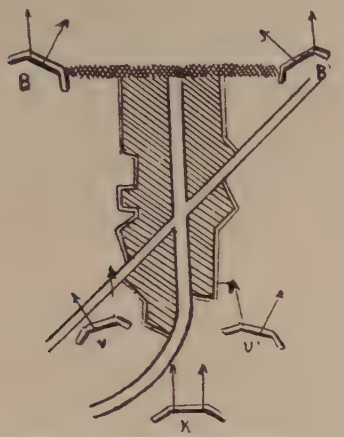


Fig. 20.—Village elongated perpendicularly.

Two groups of trenches will be dug *BB'*, covering the village. They form two bastions, whose curtain will be the edge of the village.

Complete this organization by constructing *wing* trenches *VV'*.

Organization of details of protective works.—In all cases there must be:

(1) *Clearing off the field of fire:* burning haystacks, cutting down hedges, knocking down walls of enclosures and isolated houses.

(2) *Construction of a line of obstacles,* extending those which exist (iron fencing, walls of enclosures) completed by accessory defenses.

(3) *The creation of a principal line of fire.*—Organization of walls, hedges, houses, entrenchments, sweeping thoroughly the line of obstacles and the terrain in front, with shelters for the lookouts properly reinforced.

(4) *Arrangement for flank fire* (machine guns enfilading the terrain in front of the line of obstacles). Organization of *wing* trenches, in echelon, somewhat beyond the village to avoid the envelopment. To this end, utilize the obstacles which are on either side of the village, to right and to left (walls, farms, patches of woods, cemeteries, etc.) or construct new obstacles (blockhouses).

(5) *Construction of shelters in rear.* —Complete utilization of cellars and construction of subterranean shelters which will complete the system. Galleries will connect the cellars, at any rate of the same group.

(6) *Opening of communications, or their improvement.* — Protected paths all along the line of fire. Passageways through the walls and enclosures. Make the communications always with a stepped trace and not in a straight line in streets enfiladed by enemy's fire. Put up signposts and have all the occupants familiar with the communications. Put in pipe system for water, if possible, and connect up with the wells.

(7) *Organization in the village.*— During the lulls in artillery bombardment, organize the edge of the buildings for close defense, and the supports (if the principal crest of fire is in front), and if possible a second line in the interior. If a water course of a large street traverses the village, utilize them for this second line; if not, make this line in some way.

(8) *Organization of a redoubt,* whose principal value will be due to its being defiladed from distant view. Make it, therefore, in a solidly constructed house, or in an enclosure situated so as to sweep, at short range, the exits from

the village. This point will be enclosed by systems of accessory defenses.

(9) *If the occupation is prolonged,* work unceasingly to complete the organization, so as to be able to make a stubborn fight, where necessary, from street to street and house to house. To this end, prepare an interior division into compartments with barricades and accessory defenses, which will separate portions of the village entrusted each to a company, or a constituted fraction, each portion forming a strong point.

(10) *Organization of a position in rear* to prevent the enemy from debouching from the village. To this end, construct some elements of trench to be occupied by supports, in good

FIG. 21.—Defensive organization of a large village.

range and in rear of the exits from the village.

(11) Independently of the accessory defenses which should envelope the entire village, the lines of access to the village on flanks and front must be closed by barricades, fixed and movable, except at points which should be left free for exterior counter attacks, and whose defense will have been specially organized.

(12) The judicious employment of communications, of barricades, of interior blocks of buildings, and the complete familiarity with them of the defender give him a marked advantage by allowing him to throw his reserves rapidly on any point where an enemy, who does not know the village, may have penetrated.

(13) Fig. 21 gives an example of the organization of a village.

(14) The hurry order for the construction of defensive works is as follows: Construct accessory defenses, barricades, organization of the line of fire, communications, shelters, redoubts, interior lines of defense, blocks of houses specially prepared ("islets").

(15) In the war of movement, such an organization, requiring a great deal of time, cannot be made. Depending on the time available, however, the above outlined plan will be approximated as much as possible.

46. *Barricades.*—They will be generally arranged so as to stop the enemy, not only by the obstacle they present, but also by the fire of the defenders.

They serve especially to intercept a route of access (road or trench) from which one is obliged to follow.

They may consist of a parapet of earth, of sandbags, manure, paving stones covered with earth (Fig. 22), or

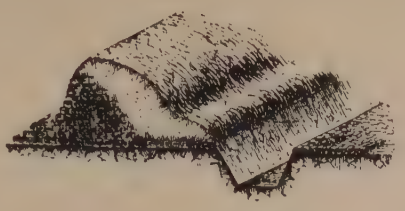


Fig. 22.—Barricade of paving stones.

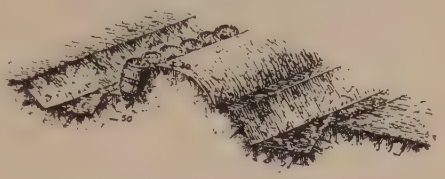


Fig. 23.—Barricade of barrels and earth.

barrels (Fig. 23), or may be composed by the bodies of carriages whose wheels have been removed or immobilized and which have been filled with nondescript material.

To permit the use of the road to the defender, the barricades are arranged in two sections, disposed in echelons, as indicated in Fig. 24.

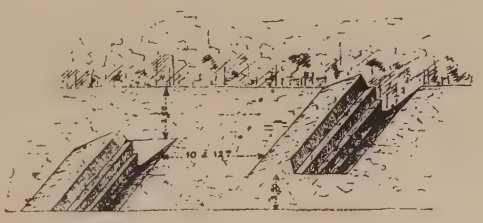


Fig. 24.

Barricades may be organized at times as simple passive obstacle; for example, to close breaches in a wall.

They are built:

Fig. 25.

With the trunks of trees disposed horizontally, one on top of the other, and held by vertical uprights and braces (Fig. 25).

With trees cut down (Fig. 26).

Fig. 26.

With a vehicle, loaded, between the wheels of which stumps, fagots, trunks of trees, are placed to obstruct the interior empty space (Fig. 27).

Fig. 27.

They are always placed far in rear of the edge of the village and on a line with a lateral street to facilitate movement.

47. *Organization of a Cellar.*—The ceilings of cellars, supported by posts, will be reinforced with logs, railroad rails, sandbags, broken stone, layers of concrete, augmenting the thickness of the arches and making exploding cushions.

The layers of railroad rails, buried in concrete, will be placed on rail sleepers passing through the walls of the house and resting outside on masonry pillars. The weight of the layer of rails rests, then, on the pillars and not on the roof of the cellar. Lacking rails, embed in the concrete articles of furniture: beds, cupboards, tables, chairs; any solid point constitutes a center of attraction and resistance for the setting of the concrete.

Assure and protect the ventilation carefully.

Arrange and protect the exits; make them double. Connect the cellars with each other by subterranean galleries. Make loop-holes on a level with the ground for machine guns.

Close hermetically all useless and unprotected openings, so that the enemy cannot throw through them explosives, inflammable and asphyxiating matter.

The crumbling of the house under heavy artillery fire only augments the protection offered by the caves if the precaution has been taken to remove from the upper structure all inflammable material.

Have a stock of tools on hand for possible clearing away. Have drinking water always on hand, vessels full of a solution of hyposulphate of soda and Vermorel sprayers to counteract asphyxiating gas.

48. *Organization of a House.*—Occupy a house only where it is not subjected to artillery fire.

Where it is subjected to such fire, prepare it but do not occupy it except at the moment of the assault. Until that moment, find shelter in the cellars or hollows of the ground near at hand.

The houses which are most advantageous for being placed in a state of defense are those of two or more stories, which have partition walls, fireproof roofs, and which have salients and re-entrants which allow the foot of the walls to be swept by fire; in such houses the men are generally behind the second or third wall.

The organization comprises the following operations executed generally by

the different work groups simultaneously:

(1) Remove the roof if it is inflammable, as well as any other useless object which may burn; in each room place buckets of water or piles of sand to extinguish rapidly the beginnings of fire.

(2) Open the interior doors to diminish the blast caused by the explosion of the projectile.

(3) Close hermetically the openings of the underground room and first floor, which must not be used. The enemy will not then be able to throw in explosives and inflammable materials. Barricade the doors with materials of big dimensions, those opening inward as well as those opening outward; do the same for the windows of the first floor and arrange in them loop-holes (Fig. 28).

(4) Remove the window shutters of

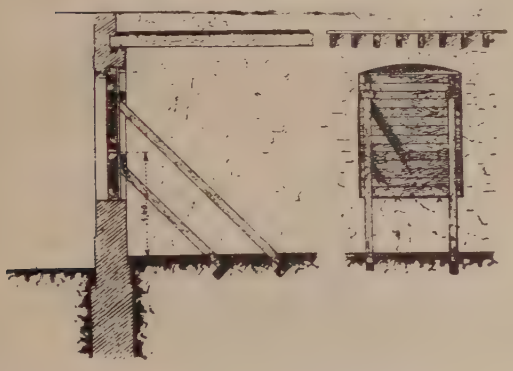


Fig. 28.—Window barricaded and provided with a loophole.

the upper stories, close the inside shutter to conceal the defenders, organize behind and up to the height of the breast a cover one meter thick with mattresses, springs, linen, trunks full of things, etc.; make loopholes in the intervals of the openings; protect the riflemen placed behind the first wall against stone splinters by the aid of mattresses, planks, etc.

Machine guns level with the ground on the first floor. On the upper stories, place them at the back of the room.

(5) In the top story place observation posts and, where necessary to get a dominating fire, some cover for riflemen.

(6) Arrange an exit in case of retreat in the face opposite that of the probable attack; barricade it, but in such a manner as to rapidly free it in case of need; make communications which permit of easy access to this exit.

(7) Organize the flanking dispositions for the approaches by occupying the salients, making, where necessary, trenches at the angles. Place accessory defenses completely around the house.

(8) Fig. 29 gives an example of the placing of a two-storied house with cellar in a state of defense.

49. *Organization of Woods.*—The tactical characteristics are analogous to those of villages. Excellent mask against sight, even of airplanes.

Generally, the enemy does not fire at troops that he does not see. Hence protection against fire.

Combats in woods are very difficult to conduct. They are like a fight between blind men. It is especially important to possess the edge.

If the topographical situation does not permit them to be utilized, they must be destroyed.

50. *Defensive Organization of the Edges and Approaches of Woods.*—The occupant of a wood has a clear sensation of being under shelter. This belief, whether justified or not, unquestionably gives his nerves a rest.

On a large wood, the effect of ar-

tillery is very small on account of the dispersion of the projectiles. The men become quickly accustomed to fighting in woods. As they neither see the bursts nor smoke of the projectiles, the defenders keep their morale.

of the trench are occupied. Hence very ineffectual fire. The principal line of fire is organized on the edge if the field of fire is sufficient.

(2) If the development of the edge is small (small woods, elongated

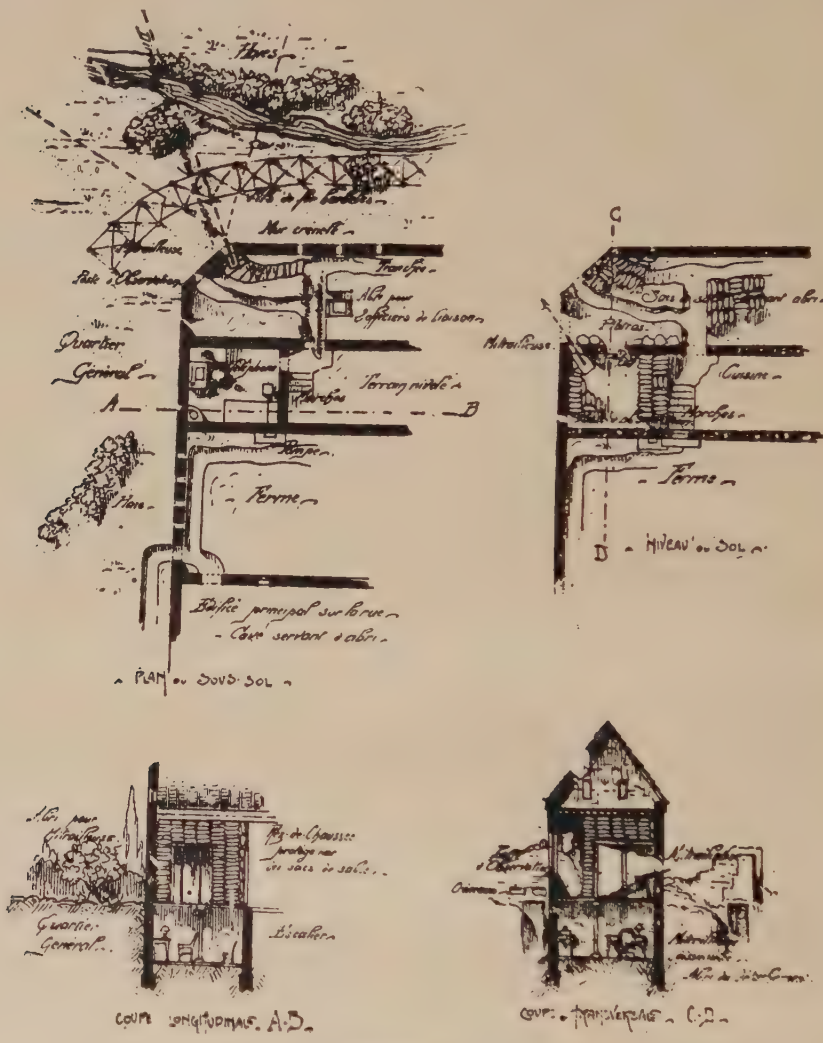


Fig. 29.—Defensive organization of a house with a cellar.

(1) If the development of the edge of the woods reaches 300 to 400 meters, the enemy, if he can adjust his fire for range, cannot do so for lateral direction, as he does not know which parts

woods), perpendicular to the front and easy to locate from afar for the hostile artillery, carry the principal line of defense 50 to 80 meters forward and organize the edge during the night or

the lulls in the fighting, for the close defense.

51. *First Case: Organization of the Crest of Fire on the Edge of the Woods.*—(*a*) If the field of fire is at least 150 to 200 meters, the edge of the wood is occupied. The salients, the exits, the points for flank fire are organized without modifying either the exterior aspect, or the vertical aspect (airplanes). The first line is placed, according to the density of the woods, from 10 to 30 meters in rear of the edge of the woods. The trees and bushes are kept on this width, or simply stripped on the lower parts to open up the view. A line of leafless abatis is established (so as not to interfere with the firing), which may be interwoven with barb wire.

(*b*) In a very thick, dense wood, where the clearing up of from 10 to 30 meters from the edge would necessitate heavy work, put the fire line on the edge itself (from 2 to 4 meters; in the ditches which one often finds on the edges of woods). Create in front at 100 meters a line of obstacles, wire entanglement, abatis, stretched wire. Behind the strip of woods, which forms a mask, make a track of 4 to 6 meters, and dig there the trenches.

On account of the presence of roots and of the possibility of defilading the relief, the parapet may be raised by an additional 2 feet 8 inches to 3 feet 4 inches, which gives a better field of fire over the brush and the abatis.

It is useful to create in places paradoses which protect against back bursts of projectiles.

When the terrain is rocky, the roots are numerous, the woods very abundant, the parapet and the parados may be constructed by means of mattresses of earth between two layers of poles. Sheds may be built, traverses and light shelters with the same materials.

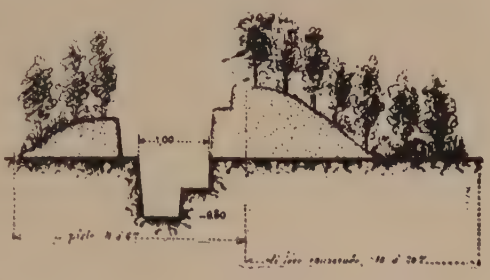


Fig. 30.—Trench in wood, with strong relief.

52. *Second Case: Organization of the Crest in Front of the Edge of the Woods.*—The edge has no field of fire, or the wood is narrow and easy to locate for the hostile artillery. The fire line must then be carried forward 50 to 100 meters. Install on the edge of the woods, trenches and abatis for supports and the close defense, according to the same principles as above.

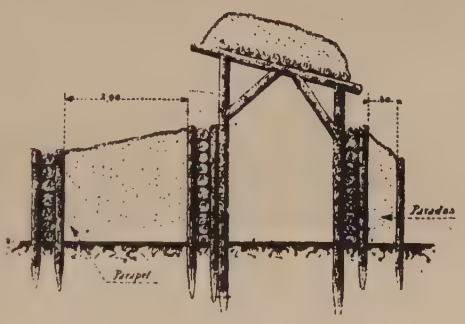


Fig. 31.—Raised entrenchment.

(*a*) *Trace of the organization on the edge of the woods* (principal fire line of the first case, support line of the second case).

The line of abatis will be organized all along the edge of the wood. If time is lacking, the abatis is replaced by wire wound about and stretched between the trees of the edge of the wood. Around

the elements of trench, passages for counter attack will be arranged, care being taken to sweep these passages by the fire of an element of trench or of a machine gun.

The salients, the debouching points of roads, the probable points of passage of the enemy, will be first occupied.

The salients will permit flanking the intervals by powerful fire (machine guns, when necessary) in front of the abatis. If the woods present a straight and continuous edge, it will be necessary to post in front of the woods, at some meters, shelters for machine guns or blockhouses, concealed by branches or by a very low relief or simply an element of tenailled trench so as to permit perfect flanking of the edges of the woods.

Progressively, the organization is completed by fire crests in the intervals themselves, so as to make the front impregnable.

Approaches defiladed, or paths, are arranged to connect the shelters with the fire trenches. In rear of the possible lines of approach of the enemy, make ambuscades; trenches enfilading roads at points where lateral obstacles will force the enemy to keep in them.

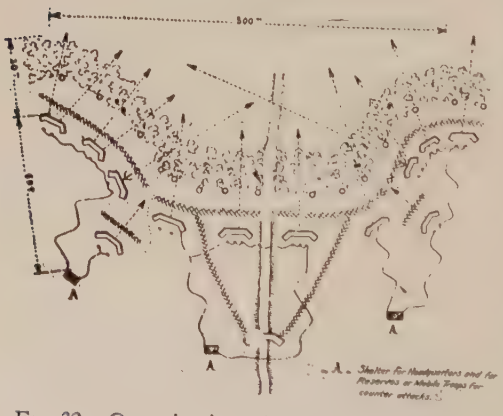


Fig. 32.—Organization of the edge of a wood.

Pits for double sentinels are established in front of the abatis of the edge of the wood. They are connected with each other and with the trenches by *chemins de ronde* of 2 or 3 meters, straight, so as to permit rapid and easy communication (Fig. 32).

(*b*) *Organization in woods.* — Occupy the natural clear spaces, the big gulleys or ravines situated in the interior, to create a crest of fire. The defense of this line is based on the employment of powerful flank fire, with very solid accessory defenses, to make up for a very short field of fire.

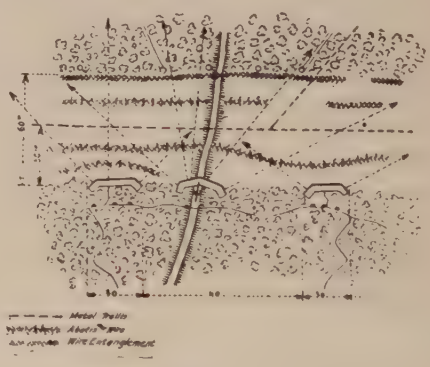


Fig. 33.—Defense in woods.

Cut the line out, if it does not exist, being careful to leave enough trees so that the vertical aspect of the wood does not change (airplanes), but clearing away so that the defenders can see the enemy for at least 60 meters to their front. The trace of the clearing is either a straight line; tenailled or stepped abatis at the opposite edge make powerful accessory defenses if barb wire is woven through them. *Make ambuscades swept by machine guns; nail metal trellis to the trees.*

Make passages in echelon for counter attacks. Watch the line of obstacles from sentinel pits (Fig. 33).

The support lines of organized positions along the edges of woods are arranged in the woods upon the same principles.

Fig. 34 gives an example of the organization of the edges of a wood.

If the wood is of great dimensions, it may comprise from the beginning an organization of spaced centers of resistance whose intervals are formed almost entirely of accessory defenses. But when the two parties are near together, and when surprises are to be feared, it will be necessary, to better hold the terrain and because of the difficulty of seeing, to create intermediate strong points and to strengthen them progressively until the intervals attain little by little a degree of solidity comparable to that of the centers of resistance.

In the war of movement this plan of organizing will be approximated, as well as the time available permits.

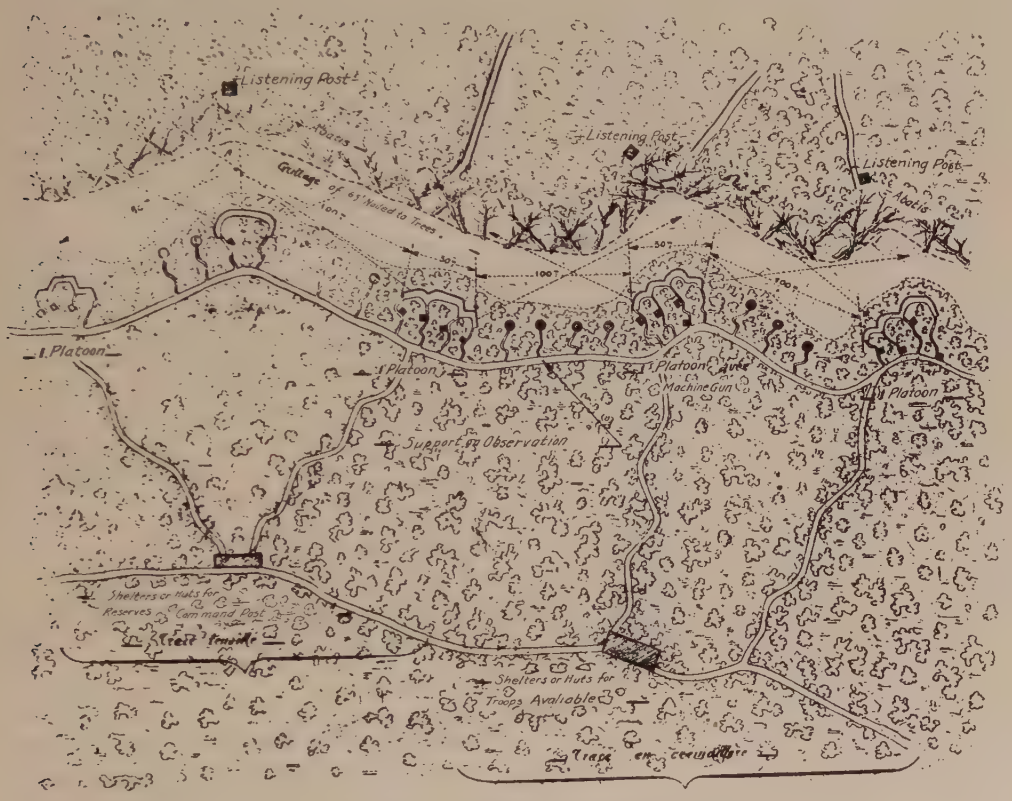


Fig. 34.—Defensive organization of the edge of a wood.

53. *Organization of a Defile.*—Bridges, fords, roads passing through villages, through woods, etc., are considered as defiles.

In mountainous country, this terrain is reserved for a valley with steep, almost inaccessible sides.

This last is the kind of defile we are now going to consider.

According to the situation, the de-

fense may be made in front, in rear, or inside of the defile.

54. *Defense in Front.*—Purpose: To keep the passage of the defile open (advance guard, rear guard).

To protect the exit and its vicinity from hostile artillery fire.—The defense is made on the arc of a circle so as to keep under infantry fire all the positions favorable to the deployment of hostile artillery, on heights dominating the exit of the defile. The distance of the defense from the line of strong points to the opening of the defile varies according to the terrain from 3,000 to 6,000 meters. *There are no support positions* (lack of space), but at the entrance there should be a barrier organized to cover the retreat of the last troops (when necessary).

Very strong wings.—Defense and barricade of all lateral routes, to prevent turning movements. Prepare measures of destruction (in a retreat march) to block up debouching points.

55. *Defense in Rear.*—Purpose: To prevent the enemy's debouching by crushing his columns as fast as they present themselves. To this end his emplacement must be restricted, and *on this emplacement must be directed a concentration of powerful convergent, continuous fire.*

Therefore, put the infantry positions within good rifle range of the mouth of the valley. Place the batteries of artillery so that they cannot be seen from the heights around the defile.

Positions must be solidly supported by flanks on high points. Avoid being turned.

Fig. 35 gives an example of the defense organization of a defile.

56. *Defense on the Inside.*—Purpose: To complete the defense in front, serve as a second line of resistance or as an advanced position, hinder the march of the enemy by accessory defenses placed under an intense fire from the trenches. The firing line is placed in rear of the obstacles, so as to have a front superior to that of the enemy, either by carrying the flanks forward and echeloning them on the slopes or by occupying a point where the defile broadens out (secondary valley).

Fig. 35.—Defense of a defile in front.

Establish the trenches on the summit of steep slopes on the military crests, for they generally have little to fear from the hostile artillery.

Assure the mutual flanking of the strong points. Watch out for and guard all secondary passages.

57. *Defensive Organization of a Stream Crossing.*—According to the situation, the defense can be made in rear or in front. This special organization is called "Bridge-head."

58. *Defense in Rear.*—Admissible procedure in case of absolute defensive, when there are no debouching points on the other side of the stream.

Watch along the stream, with mobile detachments (with machine guns), which occupy elements of trench and watch the debouching points across the river. Destroy all means of passage along a great length. Assemble the main body at a certain distance in rear so as to bring it rapidly to any point where the enemy may be caught in the act of passing the stream (Fig. 36).

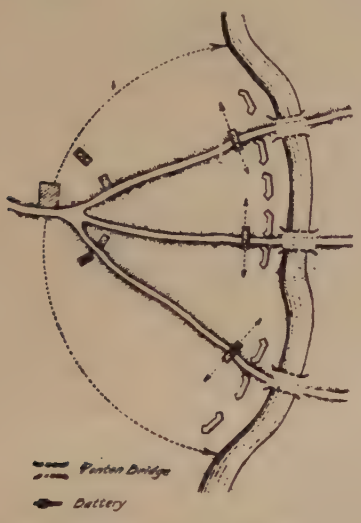


Fig. 36.—Defense of a passage in rear.

59. *Defense in Front.*—Procedure employed to construct a bridge-road. The same defensive organization covers several points, generally at 300 or 400 meters apart. A bridge-head should satisfy the following conditions:

(1) Cover the troops in the vicinity of the bridge against hostile fire. To this end, occupy the heights or emplacements which hold on fire the positions favorable for hostile artillery's bombardment of the bridge. Considering the range of heavy cannon and howitzers, it would be well to extend this line of supports to 5,000 and even 6,000 meters from the bridge (Fig. 37).

(Note.—In the offensive in Picardy, the heavy long-range artillery destroyed

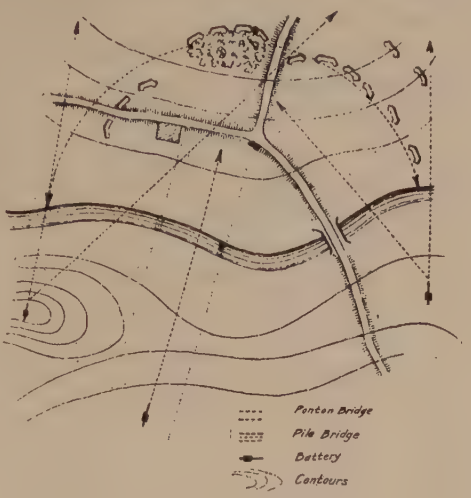


Fig. 37.—Defense of a passage in front.

points of passage for enemy at 12 and 15 kilometers.)

(2) But the troops given the defense of the bridge-head are often insufficient.

The development of the position must therefore be in relation to the strength of the force defending it.

The distance of the bridge-head must often be as near the bridge as 3,000 meters.

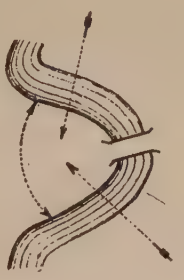


Fig. 38.—Bridge-head in a bend.

Batteries will be placed on the friendly side to support the strong points of the wings.

They must be able to act likewise on the interior of the bridge-head.

(3) Make solid strong points at the entrance to each passage. Bridge-heads are advantageously placed in the re-

entrant bends of streams. Their defense with two arms against one is then easy to obtain (Fig. 38).

CONCLUSION

60. Examples of the present war abound which prove the strength of resistance of defensive fortifications, held by a determined garrison. This strength, joined to the power of armament, is such that it may be said that troops which are well commanded, which feel themselves well supported, which the commander keeps well informed and looks out for, is capable of unlimited resistance. Mediocre strong points, submitted to frightful bombardments and to furious and repeated attacks, have held victoriously, while others, better constructed and prepared, fell prematurely because the defenders had not the necessary confidence in themselves, in their neighbors, or in ultimate triumph.

In November of 1914, the Germans having made a lodgment at Vigneules-Hâttonchâtel on the heights of the Meuse, tried to force the passage of the Meuse. A battalion of a French reserve regiment, energetically commanded, occupied, with one section of machine guns, in the Chevaliers Woods (south-east of Verdun), a defensive organization formed of elements of kneeling trenches hastily constructed, and having in their front only three lines of wire concealed at from 30 to 100 yards. (The defensive organization of the Chevaliers Woods, occupied by a division, is given in Fig. 39).

A night attack was launched by four German regiments, commencing at 10 p. m. and lasting until 4 a. m. the next morning. Provided with plentiful ammunition, the French battalion had instructions to hold to the last man.

The Germans came on in columns of fours by the forest paths, yelling, preceded by flare bombs.

For six hours the rattle of fire from the French trenches was continuous. A few Germans reached the French lines and were captured. At daybreak the four German regiments retreated, leaving 800 men killed and wounded. These men lay strewn for the most part over a zone between 400 and 450 meters in front of the French trenches. The French battalion lost 80 men.

One thousand men well supplied, well officered, energetically commanded, had stopped an attack twelve times as strong as they.

Again in November, 1914, at Ypres, the French line of attack was stopped at 300 yards from the enemy trenches, from which came a deadly fire. The Frenchmen piled into shell-holes and old trenches; badly punished, they replied poorly to the fire of the enemy, firing into the air and only breaking branches over the heads of the Bavarians.

Two French infantrymen succeeded in lodging themselves in a hole in front of their line. One of them settled himself so as to give a flank fire. Without changing the aspect of the front of his shot-hole toward the enemy, he arranged a loophole in the side. He then waited, commencing his fire when he got a target almost to his right. He then commenced to shoot from right towards the left whenever a head appeared. The Bavarians could not locate the man. They doubled their fire on the French line, then, becoming more prudent, took off their helmets and only took hasty peeps over the parapet. Then they began to shoot high and break branches over the heads of the French soldiers.

During this time the two French sharpshooters, alternating in shooting and in improving their hole, had made room for two more; these two came up, and a trench was commenced. Finally, when the trench was big enough, a noncommissioned officer and fifteen men reached it with a rush.

In front, the fire of the German trench appeared silenced; calm settled on this part of the battlefield and a truce seemed established.

FIG. 39.—Defensive organization of the sector Chevaliers Maizey Woods, southeast of Verdun.

Toward midday, suddenly the group of Frenchmen sprang up; in two rushes at full speed over open ground, they reached an old abandoned French for-

tification 30 meters from the enemy. The Germans, surprised, did not fire until the last moment; two men were wounded. All the rest of the day this small group remained there (only one man wounded). The Bavarians dared not chase them out.

At night, under the protection of this group, the whole company glided forward; they dug silently, with rifles alongside. At daybreak the Germans found a trench dug under their very noses.

These two examples, taken from a hundred, the thousand episodes of the Battle of Verdun, where the development of the mechanical power of destruction is paralleled by the resisting capability of the soldier spirit.

This spirit, when the last word is spoken, will remain superior to the effects of matter, and confirm this truth victoriously announced:

No inch of ground should be voluntarily abandoned, whatever may be the circumstances, and troops, even though surrounded, must resist to the last man, without retreating; the sacrifice on the part of each man itself being the condition of victory.

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